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EDITORIAL NOTE

DEVELOPMENT OF COLONIAL AGRICULTURE

THE majority of the sixty-seven million people living within the Colonial Empire are peasants following traditional subsistence farming methods which are proving insufficiently adaptable to meet the demands of rapidly growing populations and the impact of the economy of the western world. For many years Departments of Agriculture have struggled with the tasks of rural betterment with variable but on the whole disappointing results. Apart from the chronic shortage of staff and inadequate representation in councils of higher colonial policy, one of the main limiting factors has always been the slender resources of the individual peasant. Climatic factors make peasant agriculture precarious and the hazards have been further increased by declining soil fertility and the concomitant progressive deterioration in water resources. Motives of self-preservation make deliberate changes in traditional methods difficult to embrace for populations close to the margin of subsistence. Technical advances in world agriculture, particularly in such matters as mechanical cultivation and processing, the use of fertilisers, the control of

weeds, pests and diseases, the raising of the performance of livestock, and in the development and use of water resources, have accentuated the disparity between capitalised and subsistence production and close attention is being given to the implications in the colonial field.

" Agricultural Development " was the subject of the Summer Conference on African Administration held at Queen's College, Cambridge, in August, 1949 and this issue of *Tropical Agriculture* contains two articles on the same subject by leading authorities. There are encouraging signs of a sense of urgency and a measure of agreement is being reached upon the general pattern which development must follow. Briefly, the conclusions point to a more comprehensive approach to the whole subject, the planning of natural land units for optimum utilisation, and the organisation of the peasants into groups of an economic size to attract capital for production and processing, and to obtain the benefits of collective marketing, and sound management. Stability is to be provided by a continuation of the system of guaranteed markets and prices which proved effective during the recent war. It is fully recognized that the precise form which these developments will take must vary with every set of conditions and with every kind of people. Successful examples of group development in association with government, or a managing company, are to be found in Fiji, the Sudan, the Middle East, and nearer home, in British Guiana. Experiments have been started in Jamaica, Nigeria, Kenya, and Uganda, and in many other colonies policy is developing in this direction. The Peasant Investigation at I.C.T.A., working so far with family units, has led us to the conclusion that in order to introduce the full benefits of modern developments some form of family grouping will be necessary. It is hoped to carry this thinking further in conjunction with the Trinidad Department of Agriculture's pilot group farming experiments on the Central Experiment Station at Centeno.

The recommended approach is through the development of pilot schemes which will be at first experimental and, according to indications, demonstrational. The crucial factor, which cannot be too often or too strongly stressed, is that the suggested re-orientation of our approach to the development of colonial agriculture implies adequate staff, particularly locally recruited staff of the highest calibre, in order to carry through the necessary surveys, investigations, planning, guidance and education of the people. We must not forget that we can develop colonial agriculture only by developing colonial people, and group farming will be successful only to the extent to which we can convince enlightened local opinion of its soundness.

REVIEW ARTICLES AND BOOK REVIEWS

COLONIAL AGRICULTURE

DEVELOPING COLONIAL AGRICULTURE*

BY

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A GREAT INCREASE in agricultural production in the colonial empire is a feature of all sorts of post-war plans. From the angle of the colonial peoples themselves, living, in the great mass, at a bare subsistence level, it is a *sine qua non* of better living. For them it means more and better food to eat and means, also, with the proceeds of surpluses, more money to spend on other goods, and also on education, on health, and on other services. The world's interest is in these surpluses ; the neo-Malthusians are once more freezing our blood with tales of what will happen if output does not keep up with population, and when the Food and Agriculture Organisation plans for the future, the development of colonial agriculture is high on its agenda. The special interest of the United Kingdom, apart from its general obligations as an imperial power, is in the contribution of colonial agriculture to eliminating the dollar deficit. This is already a large contribution—colonial crops are the biggest dollar earners in the sterling area—and its expansion is the largest item in the plans now being made to balance the dollar account. The contribution is even larger than it seems, for in addition to earning dollars directly, colonial agriculture also saves dollars indirectly by providing sterling area countries, including the colonies themselves, with supplies which would otherwise have to be bought with dollars.

The demand for colonial produce is now greater than it has ever been before. But at the same time the supply has now also become much less elastic than it was before. Colonial agricultural production expanded rapidly between 1900 and 1940 ; it expanded, indeed, much more rapidly than the demand. Why then is it now necessary to give special attention to ways of increasing it further ? Can the supply not be left to look after itself in the future just as capably as it has in the past ?

The answer is decidedly in the negative. The processes which yielded increased output in the past are not now so important. If we are to have much bigger output in the future, we must look for it from different sources.

In the past greater output came in two ways. One was by the opening-up of plantations in areas of sparse settlement, and the other was by peasants taking up commercial crops, and either adding them to or substituting them for subsistence agriculture. Both these processes will be much less important in the future than they have been in the past. The extension of the plantation system is almost finished in the British colonial empire ; and the peasants have nearly all already been drawn into commercial agriculture, and in some cases, *e.g.* West African cocoa and Uganda cotton, their output is tending to fall through bad cultivation methods.

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The extension of the plantation system is finished for a reason not generally recognised. It depended on indentured labour, and such labour is no longer available. Land is available for plantations only where population is sparse. In the past the difficulty was met by bringing in labour—African slaves in far-off days, indentured Indian labour more recently—which was tied to the plantation at least for a period of years. India and China still have great reservoirs of labour, and there are still wide open spaces, in Africa, in Australia and in the large islands between Asia and Australia, but the political obstacles to bringing men and land together are proving insuperable. Australia will not admit Asiatic labour to her great sub-tropical areas. In British North Borneo there are 350,000 people on an area one-third the size of Britain, but the Colonial Office will not admit Indian and Chinese labour for fear of creating " another Malaya ". And the Indian Government itself is unwilling to permit indentured emigration, and imposes a ban on emigration to most of the areas that would welcome immigrants.

It is because labour can no longer be had abundantly that recent plantation planners have thought instead of pouring in vast quantities of capital. If the Tanganyika groundnut scheme had been conceived in 1925, it would have provided for 200,000 indentured Indian immigrants and very little machinery. Instead, conceived in 1946, it provided for £25 millions of capital, at the rate of £700 per worker, and is to be probably the most highly capitalised agricultural undertaking in the world. Unfortunately, while there was, in the old days, an abundant reservoir of Indian labour on which to draw, there is not, in these days, an abundant reservoir of capital on which to draw. We can provide £25 millions for one of these schemes, or £50 millions for two, but it is quite out of the question to do very much development of this type. The opening up of plantations in new areas has virtually come to an end, unless the Indian and Chinese reservoirs of labour can once more be made available, and there is little prospect that the political obstacles to this will be overcome, either in the receiving or in the despatching countries.

If new plantations fade out of the picture, the development of peasant agriculture becomes the principal means of expanding the colonial output, and this involves a complete revolution in our approach. In British West Africa there have never been many plantations—except those started by the Germans when they ruled the Cameroons—and the handful of officers in the Agricultural Departments have always worked primarily on peasant problems. But everywhere else it has been the plantations whose interests have been promoted, and the peasants have received scant attention. Pressure has indeed often been brought upon the peasants to leave their holdings and to seek work on European enterprises. Peasant production has expanded because the peasants have found commercial production profitable, and because merchants have found it profitable to organise their trade, but very little study has been given to the problems of peasant production, and now that it is official policy to expand such production the nature of the obstacles to be encountered is hardly even known.

That they are formidable is about as much as is generally known. This fact has impressed itself because peasant production shows clear signs of having already passed its peak. Production is not increasing, but diminishing. In some places it is soil erosion that has played havoc with production, turning to rock and desert what was once fertile land. In others, the dessication is

due to uncontrolled deforestation. Elsewhere it is simply the exhaustion of soils, overcropped, without manures or rotations. Or disease sweeping through cultivations where counter-measures are inadequate. While in Britain the talk is of expanding colonial output rapidly, in many colonies the search is rather for means of halting a decline. There will be no expansion of colonial agriculture unless we put our backs into making peasant agriculture efficient and successful.

II

The first element in a programme for peasant agriculture must obviously be education. Nothing can be done unless the farmers can be brought to accept new ideas—new methods, new tools, new breeds, new social groupings. And this is everywhere the weakest link in the chain. There is not a single colony in the whole British colonial empire, with the exception of Jamaica, that has an agricultural extension service anywhere nearly adequate to the job ; indeed many of the largest colonies can hardly be said to possess such a service at all.

If new knowledge is to reach into all the villages there should be something like one agricultural officer to every thousand farmers. Obviously this is impossible if such men are to be trained university scientists—in Nigeria it would require up to 5,000 men. But university men are neither necessary nor useful at this job. In Jamaica it is done by local men given a two-year training in practical agriculture. All the colonies need a vast multiplication of agricultural assistants, with this sort of training, to work among the peasants.

In Jamaica nearly all the peasants now belong to the fifty-year-old Agricultural Society, which has branches throughout the island. The assistants are employed by the society, and their work is directed by lay officers elected by the members from amongst the farming community. The Government provides the money, but the society nevertheless manages its own affairs. The branches are very live bodies ; each has an assistant attached to it, and meetings, demonstrations, exhibitions and other activities are well attended. The members take great pride in their society, and have resisted the attempts of some Directors of Agriculture to gain control over it. Without its educational work peasant agriculture in Jamaica would not be what it is, namely, the most vigorous of its kind in the colonial empire.

What is important in Jamaica is not the particular form of organisation but the spirit animating it—the feeling of the peasantry that this is something of their own. Mass education cannot succeed unless the masses wish to be educated ; unless we can arouse among the people a desire for betterment and an opportunity to participate in something felt to have social value. In other colonies other forms of organisation will be more appropriate, and what is successful in one part of a colony may fail in another part. But, the underlying method will always be the same, to interest the people in building up something of their own. Once a beginning is made, such a movement spreads like fire, and its achievements appear miraculous.

The organisation of this sort of work is something that has been studied in many countries besides Jamaica, but there are hardly any Agricultural Departments in the colonies that know anything about the subject. The first need is therefore for the Colonial Office to organise teaching for the teachers.

There are actually some Agricultural Officers who resist mass education proposals on the ground that the departments at present know so little about the basic problems of peasant agriculture that they ought not to try to organise mass education until they have done much more research and have something to teach. It is true that officers have occasionally made gross errors in trying to persuade peasants to adopt British techniques that were wholly unsuited to their locality. But it is not true that science has not already much to teach the colonial peasant. And we are not faced with an "either, or". We must do both—research, and teach. We must expand the highly trained scientific staff just as much as we expand the staff of assistants, and must so organise their work that there is two-way traffic of ideas between them.

The battle for research is fought, and won. Parliament recognised how important research of all kinds is to colonial development when it set aside a special sum of a million pounds a year to be spent exclusively on research. The planning of this expenditure has been the work of a number of committees under the general supervision of Lord Hailey, and a fine job has been done. Subject to the scientists becoming available, colonial research is now well established, and there is little doubt that Parliament will gladly vote extra funds for this purpose if, as seems very likely, one million proves too little.

The same cannot be said for agricultural extension work. Agricultural Departments have now nearly all submitted their programmes as part of the Ten-Year Development Plans which the colonial governments are making, and provision for such work is absent from the majority, and very meagre in the rest. It is clear that the Departments have not yet begun to think seriously in terms of mass education. Until they do, talk about increasing colonial production is so much air.

III

The second element in an agricultural programme is capital—for roads, railways, water supplies, soil conservation, livestock, implements, processing plant, and so on.

In the past, the government has concentrated its capital effort on providing roads and railways, and in some places, where revenues have been large, the network of communications is very creditable. Inadequate communications are still a great handicap to expanding agricultural output in East and Central Africa, and in Nigeria the equipment of the railways has lagged behind their need. But elsewhere further communications are not of as great urgency as they were fifty years ago ; that is to say, if part of the money now allocated to roads in Ten Year Plans were spent instead on mass education, on water, or on fertilisers, the increase in production would be much greater.

Probably the most urgent of all capital needs, in terms of productivity, is expenditure on rural water supplies. Colonial agriculture thirsts for water. Almost everywhere water supplies are too small, or if adequate in total, are unevenly distributed, or are in either case uncertain. Vast areas of land in the empire cannot be worked at all because they have not enough water, and measures for finding, conserving or distributing water can do more to increase production than can any other comparable expenditure. In the light of this, it is amazing how little has been done in this sphere. Mention Malaya, Ceylon,

British Guiana, Cyprus and Jamaica and you have named all the colonies that had irrigation works before 1939. Since then, wells are being dug in Northern Nigeria, and the search for water has begun in East Africa. But we are not yet water-minded ; the art of conserving every trickle to the best advantage has been learnt only in Cyprus.

Next in importance comes the use of fertilisers, natural and artificial. Tests in some areas have shown that spectacular increases of yields are possible by adding relatively small amounts of fertilisers ; poor seed and absence of manures are the two principal causes of low yield per acre in African agriculture. The absence of natural manure is, of course, bound up with the system of agriculture. In the large areas inhabited by the tsetse fly only the scrubbiest cattle can be kept, and mixed farming has not developed. Mixed farming and rotational systems depend on further scientific advance, to eliminate the tsetse, and also to develop profitable green manures ; meanwhile artificial fertilisers have a big part to play. Outside tsetse areas mixed farming is being pushed hard, but it involves the farmers in a capital outlay on beasts and on accommodation for them which many farmers simply cannot afford.

The fact is that, in addition to the large capital expenditures that have to be made on public works, such as roads and water supplies, there is also need for a large inflow of capital to the peasant farm itself, to finance better implements, livestock, storage, soil conservation measures, in some cases better processing facilities, fertilisers and the like. To provide capital for public works is easy, but to provide capital for the use of the small farmers themselves raises difficult problems from which most colonial governments have shrunk.

Most peasants in the tropics are spendthrifts ; their social customs impose extravagant expenditure on such occasions as weddings and funerals, and in prosperous times they are quick to borrow and to mortgage their property beyond what it can bear when the lean times come again. This has had several consequences. One is that by 1939, when prices had been moving downwards for most of twenty years, peasants were heavily in debt, and in some colonies so heavily in debt that they had no incentive to try to improve their cultivations. In such circumstances one needs the drastic remedy of " debt conciliation ", which was actually applied in Zanzibar, and also in Cyprus, scaling debts down to sums that might reasonably be borne. Since then, war-time inflation has drastically reduced the burden of debt, and many peasants have freed themselves altogether. But, peasants being what they are, it is probably desirable to make it as difficult as possible for them to borrow from moneylenders, by refusing legal enforcement to liens on crops, mortgages of property, and other instruments of debt, as has been done in various places, e.g., in Uganda and in Bechuanaland.

But if the peasant is not to be able to borrow from the moneylender other institutions must be established to meet his legitimate needs for credit. Indeed, much of his need arises from events of a kind that should be met not by borrowing but by insurance—sickness, death, marriage, fire, hurricane and drought among them. Governments have begun to enter this insurance field (e.g. compulsory hurricane insurance in Jamaica) and its extension is one of the most obvious ways both of avoiding the scourge of debt and of preventing real hardship.

In addition to such insurance, however, the peasant needs to be able to borrow capital for productive purposes. The co-operative credit movement, now spread throughout the colonies, has been absorbed in fighting spendthrift habits, and has put its emphasis upon thrift rather than upon lending. It is obviously very desirable to have societies inculcating habits of thrift. But, however hard they may save, colonial peasants are much too poor to be able to save the large sums that are needed to capitalise their farming. If there is to be any substantial headway with introducing livestock, better implements, fertilisers, soil conservation measures, and the like, colonial governments will have to be prepared to put out capital in a big way.

One or two governments are fully aware of this. The Jamaica Government, for example, has a network of village societies throughout the island to which it has been lending large sums, which the societies re-lend to their members for approved capital schemes. This has been going on successfully for thirty years. The Netherlands East Indies Government was the paragon in this sphere ; not only did it have these village banks, and rice banks doing business in kind, but it also had a monopoly of pawnbroking, which it ran both very cheaply and at considerable profit. There is no doubt that governments ought to make large sums available for lending to peasants, or that it can be done successfully on commercial lines if the service is run with care and efficiency. Most colonial governments have as yet made no provision for financing peasant agriculture, but it is difficult to see how there can be rapid progress unless they do.

The main difficulties will be found in those parts of Africa where the farmer's title to his land is uncertain, or restricted by tribal laws, so that the land is not acceptable as a security against a loan. West African rules of tenure are a veritable jungle, being strange mixtures of tribal and English laws, but the subject is so " hot " politically that the governments will no doubt continue to avoid tackling the situation for as long as they can manage. The tendency to enforce the sale of West African produce to government marketing boards, however, provides a way round these difficulties. For if the produce has to be sold to a board, the board can safely advance money on the security of a crop. This is a point of general importance. It is usual for village banks to be established as separate institutions not connected with marketing societies, but the lending programme is strengthened if marketing and credit can be tied together, by using marketing societies—whether voluntary co-operatives or compulsory—as the agents through which capital is made available for farm improvements.

Another sphere into which government funds are being drawn is the provision of machinery for cultivating the land. This has obviously an important part to play where entirely new areas are being opened up, but it is less important in existing settlements. Such settlements tend to be well populated. There is adequate labour for cultivation, and what the farmers need are better implements, such as forks and spades made of iron in place of the wooden digging stick, rather than expensive tractors. Nevertheless, there are areas where the farmers could work much more land than they do if such machinery were available, and since the average farm is too small to carry such machinery, and to maintain skilled staff to look after it, the best result is obtained when there is a single specialised agency in each district that owns

the machinery and does the farmer's job for him in return for a fee. The classical pattern is the Machine Tractor Station in the U.S.S.R. Several colonial governments are toying with this idea, e.g. the Government of British Guiana, which has set aside a fairly large sum of money for the purpose. Some of the Native Authorities in Nigeria are also thinking along these lines.

This will become a very large movement if the ratio of cultivated land to rural population increases in the colonies, either through opening up new lands, or through population leaving the country for expanding industrial employment in the towns. These are, of course, the normal roads of progress. Output per head is increased in agriculture by making it possible for fewer hands to cover a larger area and get a higher yield per acre. But it is not what has been happening in the colonies in recent years. On the contrary, nearly everywhere population pressure has tended to increase, and in some it is already acute. It is very important to reverse this movement, both by opening up new areas, and by creating secondary industries to relieve the pressure on the land. We shall deal with the former of these remedies in a moment. The latter is outside the sphere of this article, but its importance must not be forgotten. If, in these two ways, population pressure is reduced, the scope for mechanical cultivation will grow.

Governments are also beginning to put capital into processing plants. Sugar factories, rice mills, cotton ginneries, vegetable oil factories and similar processing plants are a traditional sphere for private enterprise, but they are not a sphere in which it has been very successful. In the first place, this being a popular form of investment, private entrepreneurs usually start off by building too many plants, each too small. At first their cut-throat competition benefits the peasant (though occasionally it leads also to deterioration of quality in processing, e.g. to badly milled and broken rice). But this phase seldom lasts long. It is followed by agreement between the owners of the plants, who share out the market between them, and levy processing charges fully adequate to cover their costs. Where these owners have great political influence—which is usually the case, since they are the colonies' capitalists—several colonial governments have given these agreements the full backing of the law ; but even a hostile government does little more than prevent the charges from exceeding costs, and since these costs are excessive because the mills are too numerous and too small, it is the peasant who ultimately carries the load. There is not a single colony where an excessive number of processing plants is not an active problem, and where one committee after another has not been seeking for twenty years some formula for scrapping some of the plants and concentrating the processing on a smaller number of larger and more modern plants. And meanwhile the peasant pays.

Even if this problem were solved, and the right number of plants existed, private enterprise in this sphere produces insoluble social problems. The processer has a local monopoly, and the farmers are never satisfied that he is not exploiting them. Some governments have done their best through legislation carefully to regulate the charges for processing, but this remains one of the greatest sources of political disorder, and even, occasionally, of riot. And it is aggravated by the fact that the peasants are usually poor men of one race, while the processers are rich men of another, so that all the principal

sources of human conflict are concentrated here. Quite apart, therefore, from the questions of economic efficiency considered in the preceding paragraph, we are, for the racial, political and social reasons of this paragraph, compelled to write off private enterprise in processing as a social failure.

Government enterprise is not much better for the simple reason that to the peasant the government too is a foreigner of whose good intentions he is suspicious, and to whom he is frequently actively hostile. Success lies only in the co-operative form of organisation, where the peasants manage their own processing. But the usual forms of co-operation are suitable only to processes that are efficient on a relatively small scale, such as cotton ginning. A modern rice mill or sugar factory is too large an undertaking for a peasants' co-operative to run successfully. The solution may lie in a mixture of government and co-operative enterprise. The government may put up the money for a plant, compel the peasants to sell their produce to it, and at the same time invite them to form a society connected with the plant, and to nominate a board of management. Something like this worked very successfully in banana marketing in the Windward Islands up to the outbreak of war in 1939. Native Authorities may also prove to be suitable bodies for operating such plants, and some of the Nigerian Authorities are now preparing to advance into this sphere.

Quite clearly, when all the purposes for which capital is required are added together they make a formidable bill, and it is not therefore surprising that most colonial governments make provision only for public works, and even in many cases only for very limited public works in rural areas. But is the bill really so formidable ? Vast sums have been made available for plantation enterprise, in the past by private capitalists, and more recently by Parliament. No one would expect to develop plantation agriculture without putting a great deal of capital into the land, and it is really extraordinary that while there has been much talk of developing peasant production, the fact that this cannot be done without investing much capital seems almost entirely to have escaped notice. It is a part of our tradition that while we think nothing of putting £25 million into a plantation scheme, we shrink with horror from the thought of putting up £25 million for peasant farm improvement in Nigeria, though it is by no means clear that the latter would not be more productive.

IV

Trying to alter the habits of peasants in settled areas is a formidable task ; it is easier to make and enforce rules where new areas are being brought under cultivation for the first time in land settlement schemes. There is much scope for this, in planning colonial agricultural development, and we must indeed look to the opening-up of new areas for much of the increased output required in the next few years. There is much open space in Africa, in British South America, and on the Asian islands, and as we proceed with building roads, driving back the tsetse fly, or finding or diverting water, new land will be available for cultivation. We have already seen that very little of this will be taken up in plantations, whether of the old kind based on indentured Indian labour, or of the new kind based on heavy capitalisation. It is on the settlement of free peasants, from adjacent areas, that the cultivation of these new lands will depend.

There is an opportunity on such lands to avoid the practices which are already reducing the fertility of existing settlements. If the land is merely thrown open to peasants, they will cut and burn forests indiscriminately, neglect soil conservation, destroy fertility, and, in extreme cases, make deserts. If, on the other hand, settlement is carefully controlled, there is possible a very fruitful partnership between central authority and individual initiative. This is already clear from experiments that have been made in such places as Palestine, Fiji, Mexico and the Sudan.

In the first place, settlement is more likely to succeed if the authority plays a full rôle in undertaking necessary capital works. Roads and adequate water supplies are the absolute minimum, while some mechanical clearing of trees is also a help. The settler needs money to purchase livestock and to build a house, and will look to the authority for a loan, in cash or in kind. The authority, in its turn, is interested in soil fertility, and should stipulate cultivation practices and conservation measures as a condition of tenure. Land settlements in which the authority plays a less positive rôle than this are, like the West Indian land settlements, almost certain to end in failure.

Still more fruitful partnership is found in systems where the authority retains responsibility for cultivating the soil, and limits the settler's rôle to planting and reaping. This is appropriate where configuration, climate and crop make mechanical cultivation most economical. Then the land, though divided into individual settlers' plots, is annually ploughed in a single operation under the authority's control, as in part of the Fiji sugar industry, and the settler takes over responsibility only after the ploughing, and even then may be subject to restrictions on planting, manuring, reaping, or selling. Such schemes have been remarkably successful ; they combine the advantages of large-scale mechanisation, science and supervision, with the initiative and quasi-independence of the small man, and show superior yield per acre and per man. Considerable variety is possible in the terms of the partnership, giving greater or smaller responsibilities to the authority according to the physical features of the land, the nature of the crop, and the psychology of the peasants. But it is clear that partnership on these lines offers the best prospect of success, and that governments which continue to make land available to peasants on the old unrestricted terms are failing in their duties.

We may also expect to see further experiments in communal settlements, of which there are already examples in the colonial empire. In these settlements the land is not divided into separate plots and individually owned, but is owned and worked collectively. The advantage of this, like the advantage of the type of partnership just discussed, is that it retains the economies of large-scale farming. The average colonial peasant works five acres or less, which is much too small a unit. Given draught animals, or access to centrally operated mechanical equipment, he might be able to work with his family perhaps 30 acres or so, in annual crops (much more in tree crops), which is a tremendous advance. But some crops are most economically cultivated in units of up to 300 acres or more (e.g. sugar cane), and here we need either the type of partnership just mentioned, or full-scale communal farming.

It seems, however, unlikely that communal farming will be a roaring success in the colonies for many years to come. A communal farm has to be run like a plantation ; the members must accept the full authority of a

manager, and carry out the tasks allotted to them. The system demands as much discipline as a private plantation. Now, whereas such discipline is forthcoming in areas that are over populated, it is notably absent in areas that are sparsely populated, and this of course is the reason why plantations in such areas have needed to have indentured labour, and why plantations are now likely to be ruled out. The co-operatives will probably have the same experience. In Palestine, where members are linked together by religious and nationalist fervour, they may survive, but elsewhere they will degenerate into little more than government plantations with profit-sharing schemes. The future lies with partnerships of government control and individual enterprise.

If thriving and highly productive new settlements are established, not their least value will be to stimulate among peasants in existing settlements the desire for new forms of organisation. The peasants' farms are too small, and we need to effect a revolution which will reduce the number of holdings and create larger and better-laid-out farms. We need also to persuade peasants to co-operate more, in such matters as drainage, soil conservation, mechanical cultivation, processing and marketing, and also to accept supervision and restriction of practices likely to damage the soil or to spread disease. If such things are imposed on new settlements right from the start, and peasants in old areas see that those in the new are much more prosperous, it will become easier to get new habits and controls accepted in the old areas.

Once again we may note that all this imposes upon governments a great burden of capital provision. It is they (including the Colonial Development Corporation) who have to find the money for opening up the country, and providing roads, water, working capital, and the like. But the sums required for such settlements are not greater—in fact they are much less—than what would be required to establish plantations. The idea seems strange only because we are not used to thinking of colonial peasant agriculture as a sphere for capital investment, and have so far made only negligible provision for the capital that this kind of agriculture needs. It is not only in the minds of the peasants that a revolution is needed. We too must think again, and begin to revise our ideas and our institutions if colonial agriculture is to make the contribution which is expected of it, and of which it is fully capable.

V

A final word must be said on marketing. The organisation of marketing has been reviewed over and over again in most colonies, and the principal sources of weakness and of waste are known. It is rather the external problem that needs to be considered.

Most people are reluctant to embark upon a new venture unless they can see a future in it, and peasants are no exception to this rule. This is the reason why there is a demand from most of the colonies for long-term contracts, and this in spite of the fact that the bulk contracts made in the last few years have mostly been unfavourable to colonial producers.

If prices under bulk contracts are to be such that over the average of the years they are equal to the free prices, the main advantage to the farmer is increased stability. Farmers attach much importance to this, but if they do not get it they will probably continue to produce as before.

It is when one is trying to increase production, and especially to get peasants to start producing crops with which they are unfamiliar, that it makes a tremendous difference to be able to offer a guaranteed market. There are, for example, many colonies which will start to grow tobacco, or groundnuts, or sugar, if they are guaranteed a market but not otherwise. This does not apply to all commodities. If the local merchants know the crop, are willing to handle it, and know that they can always dispose of their purchases on an organised market, supplies may flow easily in response to favourable prices. But there are many cases where a firm contract will make just the difference to the undertaking of a new venture. Accordingly, whatever may be the fate of bulk buying in general, it is important that government agents, including the Colonial Development Corporation, should be free to make such contracts in particular places where they are trying to expand supplies.

There is, indeed, much to be gained by combining this function with some of those previously discussed. If a public corporation wishes to start the cultivation of a commodity in a particular area, instead of setting up highly capitalised plantations, it can enter into partnership with peasants. It can start a small plantation, as a model and demonstration centre. Then it can offer peasants contracts to buy what they grow. If there is adjacent virgin land, it can prepare this land for cultivation, and then lease it out to peasants, on the one hand providing advice and working capital, and submitting their practices to supervision, and on the other hand contracting to buy what they produce. It is much to be hoped that the Colonial Development Corporation will act as much as it can upon these lines. To develop the colonies we must supply initiative, knowledge, capital and markets, and all these come together in this sort of partnership.

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Can it be said that we are well on the way to increasing colonial agriculture ? The answer is decidedly in the negative. We have not yet got past the stage of thinking in terms of new highly mechanised plantations, and begun to put the emphasis on increasing the yield of native production. In consequence, the provision for agricultural education is meagre, the capital needed to expand production has not been set aside, and the necessary institutions are not being established. To change the traditional emphasis of one of the oldest departments of the British Government is naturally a very long job, but, until it is accomplished, a potential source of wealth remains relatively undeveloped.

PEASANT AGRICULTURE*

By

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Introductory

During your membership of the Second Course you will, amongst the numerous subjects which make up the sum total of your Course, be given a series of lectures on Colonial Agriculture, and in this talk I do not propose to trespass on the material included in those lectures.

Rather I felt that in this introductory address I should attempt to stimulate your thoughts and discussion along lines not of technical agriculture but of the organization and re-organization of peasant agriculture at which I feel strongly we must aim if the production of agricultural wealth by the peasant producer in the Colonies is to expand to the degree necessary, firstly to maintain and improve the standard of living of the people, and secondly to maintain the extended social services which in all territories are planned and being brought into being in this postwar world, stimulated by the funds made available under the Colonial Development and Welfare Act.

Attention is constantly being focussed on the complementary part which the development of the Colonies, particularly the African Colonies, must play in the economic rehabilitation and development of western European economy, and we are assured that this complementary association is no short term objective which will come to an end when Europe has recovered from the effects of the war. But that there is a need for a large permanent readjustment of supply of primary produce as between the eastern and western hemispheres, which, prior to the War, had been in a state of unbalance. That is that we had for some time before the War been in the position of buying more from than we had been selling to the western hemisphere.

The stage is set therefore for a large expansion in the production targets of the Colonies in the knowledge that there is an assured market for our products.

I am not going to enter in this address into the controversial field of the marketing arrangements including the price policy which should be developed in order to ensure stable markets at fair prices for colonial produce, although these are of vital concern as factors in increased production.

Nor shall I discuss the place of non-native agriculture, itself an important factor in agricultural production in the Colonies both from the point of view of its direct contribution to the volume of agricultural wealth produced and also because of its importance as a demonstration to the indigenous peasant farmer of the results of the application of modern methods to agricultural production.

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* Talk given at the opening of the Second Course at the Summer School, St. John's College, Cambridge on the 11th September, 1948, reproduced by courtesy of the Author to whom our acknowledgmments are due.

Our problem in the Colonies amongst the peasant producers is so to raise the efficiency of production that to put it graphically as it was by Mr. Henry Wallace after his visit to China towards the end of the War : whereas in China it takes the efforts of four families on the land to feed one urban family, in the States one farmer and his family produce sufficient to feed four city families, and to anyone who is familiar with the industry and intelligence of the Chinese farmer, particularly the market gardeners as seen in our Colonies in South East Asia, there is little doubt that the problem in the African Colonies is not more favourable than that of China.

We must naturally recognise that in China and in the Colonies generally there are certain factors which will operate to prevent the realisation of the efficiency of the large scale farming of the United States where mechanisation and more mechanisation is the objective aimed at replacing hand labour as far as ever possible by the machine. Such a policy is possible in a country where land in unlimited area was available with scarcely any human population, and where since the early days increases in population have been more and more concentrated in urban areas to meet the needs of an expanding industrial age. In China and in the Colonies we are faced with a certain density of population on the land which must be maintained by agriculture as a vocation and in fact, with improved health and social and economic conditions, we must expect an increasing density of rural population, with so far very little possibility of diversion to industry.

Under these conditions, the objective in mechanisation cannot proceed as far as in the United States, but must be regarded as one of assisting rather than replacing hand labour in the production of agricultural wealth.

I have therefore called this talk The Organisational Development of Peasant Agricultural Production in the Colonies.

The Peasant Holding

In most Colonies the basic structure of the agricultural economy of the country is centred in the individual family holding, in many cases little altered in its system and practices from the subsistence farming which has gone on for centuries, and which, given no contacts with the industrial West and given a stability of population through disease, famine and war, could have carried on indefinitely as a system suited to the needs of the inhabitants of the Colonies.

But the question we have to ask ourselves in these days is, " Can we continue with this as the basis of agricultural production, even if we improve the methods of the individual cultivator, provide him with improved planting material and stabilise his farming by consolidating his holding and transforming his system of shifting cultivation into one of orderly rotation with the replacement of his long course of bush fallow—8–20 years depending upon the quality of the soil—by some form of established ley with grass or bush ? ".

One school of thought in the Colonies constantly preaches the gospel of a slow evolution of peasant agriculture paying attention with almost reverential care to the established native agricultural practices and I should be the last to decry the excellent work which has been done in most Colonies by the Agricultural Departments and the Administration in effecting a gradual improvement in peasant agriculture, work which must continue and be

intensified quite apart from any new development which may be tried. This of course raises the whole question of the development of mass education or community betterment, which if time permitted we could very profitably discuss.

But I would suggest that the major difficulty here is the necessarily slow pace of the change, which cannot keep pace with the growth of population nor with the desire of the individual for a higher standard of life.

I would make the plea that whilst we pay due regard to the established practices in the Colonies, we should not be afraid to consider and try out revolutionary changes in the organisation, system and methods of agriculture in the Colonies.

Where, as in certain Colonies, can be seen peasant agriculture, using traditional methods side by side with non-native farming using up-to-date systems and methods, it is difficult to accept the view that "little by little" must be the policy in agricultural development. For example in the case of Northern Rhodesia, European maize farmers using proper rotations, mechanised production and artificial fertilisers get as high a yield as 15 bags to the acre as against a yield of 2 or 3 bags in the native reserves adjoining and even the advanced native farmer following the advice of the Department of Agriculture obtains only 6-8 bags to the acre.

Similarly the example of the large sugar producing units in some Colonies provide an outstanding example of the increase in production of agricultural wealth which the application of large scale organisation and modern methods can achieve.

Naturally we must by careful experimentation and trial satisfy ourselves that any systems of farming or agricultural methods are sound under the conditions obtaining in the territory in which they are introduced and must avoid any automatic transfer of methods and systems of agriculture developed under temperate conditions of agriculture to the tropics with their marked differences in climate and soils, requiring on the whole much more careful management because of the lower inherent fertility level and the greater dangers of soil erosion in the tropics.

But this careful experimentation and trial is a function of the Departments of Agriculture in the Colonies and whilst I hope that all of you will take a very live interest in the agricultural experimental work in the Colonies we must for purposes of this talk assume that such work is being done. We have, I believe, in most Colonies now accumulated sufficient evidence as a result of experiments to prove that yields of most crops greatly in excess of those obtained by the ordinary peasant farmer can be obtained by the adoption of methods fully proved by the Agricultural Department, the difficulty in nearly all Colonies being to get these methods generally adopted by the peasant agriculturist.

Here I would digress for one moment to say that experience generally is that in the case of improved planting material produced by the plant breeders, peasant farmers are only too eager to obtain such material, and in Nigeria last year I came across a good example of this in the case of groundnuts where a new variety K.38 was evolved by the Department of Agriculture and distributed to selected farmers in various villages. The increased yields from the use of this seed had thus become widely known and three years after the start of the experiments the seed of this variety was being purchased by farmers at a price four times that of the local unselected seed.

I often feel that in planning the agricultural development of peasant communities in the Colonies we can learn much and see much that is comparable with the conditions in the Colonies, by a study of the development of agriculture in these Islands and I will if I may sketch a brief picture as we know it of the development here. There is evidence to show that the earliest form of agriculture was one which was confined to the upland areas where the least labour told the most, the rich valleys, damp and filled with forest growth remaining uninhabited and untilled.

The most primitive form of agriculture was that known as " wild field-grass", husbandry. Joint occupation and joint tillage were probably its characteristics as they afterwards were of tribal or village communities. In this form of convertible husbandry, fresh tracts of grass were successively taken in, ploughed and tilled for corn and as the soil became exhausted they reverted to pasture.

This system of farming under shifting cultivation as we now call a comparable system in the Colonies was displaced, probably under the influence of the Roman occupation, with their experience of continuous tillage in a drier and less variable climate, by the permanent separation of arable from pasture land.

The Saxon invasion after the 4th Century caused a radical change in agriculture. The open field system, with long narrow fields, was introduced and continued until the 18th Century. Not only was a new system introduced but the old eroded fields were abandoned and cultivation moved from the uplands to the lowlands.

If we turn to the 14th Century, the picture is one whereunder the land of the Manor was divided into three unequal parts. The smallest, a compact block, enclosed as a reserve for the private use of the Lord of the Manor and held in individual occupation ; a far larger part occupied and cultivated on co-operative principles by the villagers in common, under a rigid system of management ; the third part, common pasturage, fringed by the waste in its natural wildness. Over this pasture and waste common, rights were exercised by the Lord of the Manor in virtue of his ownership, by the village partners in virtue of their small holdings, and by the occupiers of certain cottages to which rights were attached.

In the large part occupied and farmed by the villagers in common, the low-lying land near a stream was permanent meadow land used for hay and divided up annually and allotted by ballot amongst the villagers. The permanent arable land beyond the meadows was divided into three great fields, each of which was sub-divided into a number of flats or furlongs separated from each other by unploughed bushgrown balks of varying widths, and these flats were in turn cut up into a number of parallel acre, half-acre or quarter-acre strips divided from each other by similar but narrower balks and coinciding with the margins of ploughed fields into ridges and furrows.

After the harvest of the arable crops and after the carrying of the hay from the meadows, the whole of these lands were thrown open for communal grazing by the livestock of the village.

We had therefore a system not markedly different from that in many parts of the Colonies if we replace the Lord of the Manor by the Chief or the head of a clan or family group, with no individual ownership of land but with common use of some of the village land and with a right of user awarded annually to the members of the community, of individual holdings in the arable lands in which each individual would have a number of scattered plots

This system proved reasonably satisfactory as long as the village agriculture was aimed at meeting only the needs of the village, in fact subsistence agriculture comparable with that of the indigenous people of the Colonies prior to the impact of the industrialised western Europe on their economy.

But because of common ownership and the rigid system of management, and the abandonment of the pre-Roman system of shifting cultivation for one of continuous cultivation, the fertility of the arable land gradually declined, and a holding of say 15 arable acres with 5 acres under wheat which in the 13th Century had provided the necessary food for a family failed to produce it 200 years later. Soil exhaustion was squeezing out the smaller man. So enclosures developed primarily because of decrease in fertility, which could not be rectified so long as the three course rotation of wheat or rye, oats, barley beans and peas, and bare fallow had to be rigidly followed and the progressive individual was deterred from following improved systems such as the introduction of a root crop or temporary ley of artificial grasses into his arable land.

Finally the industrial revolution killed the village craft and hand industries and made village agriculture a trade rather than a subsistence. It was necessary, in the national interests to provide surplus food for the urban population, and subsistence agriculture, as previously practised, proved incapable of the task.

Well that is a brief summary of development which took place in British agriculture and from a condition not markedly dissimilar from that of shifting cultivation in the Colonies with a subsistence economy barely able to support the needs of the actual cultivators themselves we see it in its present position as the most efficient agriculture in the world.

Development of Peasant Agriculture in the Colonies

What lessons can we learn from the centuries of experience which we might find useful in the Colonies ?

With this picture before us I suggest that we need not suppose that it is necessary for peasant agriculture in the Colonies to proceed slowly through a long period of evolution until it attains the efficiency, specialisation and re-organisation which has converted British agriculture from that of a subsistence agricultural economy to a highly efficient industry producing more and more of the food requirements of this country with less and less manpower per unit of agricultural wealth produced, but should be bold in our conceptions and courageous in our experiments at establishing an organisation of peasant production which lends itself to the adoption of modern methods, specialisation within a community and a far greater output of agricultural wealth per unit of man power than has so far been considered possible within any reasonable time.

British agriculture in the days of the open field system was probably based on a better appreciation of land usage than is evident in most primitive communities in the Colonies, with its allocation as between arable land, permanent meadow, permanent grazing and waste land, but it is suggested that given the knowledge now available in respect of rotation of crops, soil types, the use of grass leys, the feeding of livestock, the use of artificial fertilizers, modern methods of control of pests and diseases and perhaps, above all, the assistance of the machine, it would have been possible, granted a sufficiency of capital and adequate leadership, to have converted the open field system of 18th Century England to a modern form of agricultural production in which, whilst retaining the rights of the individual to his fair share of the products of the soil, the benefits at present obtained from large individual farms under private ownership would have been secured. We have only to look at or rather hear about what has been happening behind the Iron Curtain, to realise that something of this kind has been attempted in other backward agricultural communities. We might even believe that this latest attempt in the early stages went too far and sowed the seeds of its own failure, particularly in its conception of the complete abolition of any individual rights in property. I believe the latest development of collectivisation in Russia is a combination of private and collective ownership and we can possibly learn something from this latest development.

Similarly in other parts of the tropics and sub-tropics we have examples of organisational development of the small peasant producer in the shape of the Sudan Plantation Syndicate and the Alternative Livelihood Scheme in the Sudan, the Jewish Agricultural Settlements in Palestine, the Latifiyah Estates in Syria and of course the East African Groundnuts Scheme, although perhaps for our purpose we should regard the last named as an example of a large scale State Farming venture rather than a case of organised peasant co-operative endeavour.

Details of some of these and other schemes will be found in Keen's book "The Agricultural Development of the Middle East".

What then can we learn from all this in our consideration of the organisational development of the peasant producer in the Colonies ?

I am going to suggest that for successful development four things are necessary :—

(1) A system of land tenure which, whilst ensuring in perpetuity the right of occupation of the land to a community or a group of people, allows of individual tenure of some part of the commonly held land, with such safeguards as are necessary, and thus creates a pride of possession and a sense of security in the community and in the individual members of the community not less than that of a good tenant farmer in this country, but so framed that a system of compact holdings is maintained as an essential feature of the system and fragmentation becomes impossible.

(2) An organisation of the lands of such a community which, whilst following the best precepts of land utilisation, can provide for the maximum efficiency of production and the incorporation of modern aids to production.

(3) The development of a community so as to allow of specialisation within the life of the community and providing scope for the more progressive members of the community to satisfy their ambitions within the community instead of having to remain as members of a one grade society or leave it.

(4) Adequate capital resources to enable the organisation to be established and function efficiently.

I will deal with each of these in turn and suggest a picture of the development I have in mind in its application to an African community, and the means we might adopt to prove this possibility.

Land Tenure

To deal then first with Land Tenure ; and in this connection you will no doubt have included in your reading Meek's book on " Land Law and Custom in the Colonies " which is full of information. This picture of development is naturally not one of universal application and deals only with conditions in which the cultivation of annual crops is the basis of the farming system. For special areas with tree crops as the basis of the economy a different pattern will be necessary but the same principle of group development is suggested.

I suppose it is true to say that in all Colonies, the peasant guards most jealously his right to the use of land and his constant fear and suspicion is that by some means the powers that be are constantly scheming to take away this right.

Native systems of land tenure vary from Colony to Colony and within a Colony but in many cases we have a common feature which persists in the shape of a community right to land either in the shape of a family group, a clan or some other social unit, in which there is a recognised authority having the power to allocate land to individuals within the community. Discussions on land tenure usually argue the merits of individual freehold as against individual leasehold occupation of land, but I am going to suggest that wherever we have still existing this collective right in land, it should be stabilised by giving legal sanction to this group right of occupation, the land where possible being easily recognisable as bounded by natural features such as streams, swamps or hilltops. It should I suggest be made clear also that any buildings, or other capital works established on such land pass into the ownership of the community. If this were established I cannot help feeling that some of our unfortunate experiences in the maintenance of schools, dispensaries, wells and even soil conservation works might not have arisen, such works at present being far too often regarded as belonging to Government and not to the community. I recall the statement of a Deputy Provincial Commissioner from Tanganyika some two years ago at a conference similar to this stating that before he left to come on leave, one of his District Commissioners had been deputed to rediscover and re-map soil conservation works, which had been established only some few years previously and which had become overgrown and broken down through neglect.

In short the small unit of society should be regarded as tenants in perpetuity of the small estates which they occupy, with tenant rights in the improvements which may be effected on that estate during their tenancy.

The individual members of the community would under such an arrangement be allocated permanent holdings in the arable lands of the estate and house plots as sub-tenants of the community again with assured tenant rights in any improvements which they might make to their holdings, with the right, on death or vacation of the holding to compensation for such improvements. This could be effected by sale of the lease or by the right to bequeath the lease to an individual, but no fragmentation would be allowed. Should conditions so permit, I could see no harm and indeed should regard it as desirable that any individual tenant of one holding could by purchase of the tenant right occupy more than one holding, in order to satisfy the reasonable ambitions of the more progressive members of the community. Under such a system the head of the community would have the right to raise rents on the holdings either in cash or in kind as a tithe, the proceeds of which could be used for the needs of the community in improving their joint estate in such matters as dam-making, fencing, &c.; the principle being that any such revenue was retained inside the community and used for the betterment of the land and its peoples.

In the case of the non-arable land—permanent pasture, swamps, village woodlots—these would not be leased to individuals but communally owned and the head of the community would again have the right to charge such fees as were agreed upon for grazing rights, collection of firewood, fishing, &c.

All this, I know, is a very controversial topic, but I suggest that until we get nearer to the land, in certain of our administrative measures and machinery, we shall not create the direct interest and sense of responsibility, which are essential for good estate management and good farming.

Organisation of Agricultural Lands

To turn now to the second point—the organisation of the agricultural lands of such a community which whilst following the best precepts of land utilisation, can provide for the maximum efficiency of production and the incorporation of modern aids to production.

Firstly this pre-supposes that the whole of the land of a community is mapped out and allocated to its optimum use to meet the needs of the community, the lower swamp lands or river side wet lands for either cultivation of dry season crops or fodder or wet land crops such as rice, the lower, moderate hill-side slopes for arable cultivation with where possible the incorporation of leys as a part of the rotation, and the upper slopes for permanent wet season grazing with the hill tops reserved for village wood lots and house sites. Such an initial allocation is not a highly technical matter and is well within the competence of local staff trained in the practical aspects of good farming and proper land utilisation. It would in most village areas, as we know them involve some redistribution of the village lands. The land allocated for arable cultivation would be permanently safeguarded against erosion by the establishment of such anti-erosion measures as may be appropriate, in most cases by a series of grass strips some 2 yards wide at intervals of 35 yards down the slope. The individual holdings of initially some 30 acres each would be compact holdings running up and down the slope so that each individual had included in his holding all grades of soil.

The individual holdings would be contiguous and all the holdings would, under the terms of their sublease, initially at any rate, be cropped in accordance with a common rotation in order to facilitate the use of implements, for initial and follow-up cultivation, and harvesting, where harvesting machinery was used. In addition as far as possible common sowing dates would be used on all holdings.

The arable lands with due regard for proper land utilisation would probaly not comprise one compact block of land, but the aim would be so to arrange the layout as to facilitate the economic use of common implements through a number of holdings.

The non-arable parts of the village lands would be used communally by the villagers, but either by controlled herding or by fencing—to be avoided if possible—sound pasture management would be followed.

The grass in the grass ley course of the arable rotation would be either grazed under strict control or conserved for fodder either as hay or as silage, it being essential if sound animal husbandry is to be followed that out-of-season fodder should be available for the livestock of the village in the dry season, which is a feature of most of the Colonies.

The area reserved for the village woodlot would be properly managed so as to conserve it as a permanent source of fuel and building poles for the village and such areas would also be used as supplementary grazing areas or possibly as grazing areas for young stock.

You will notice that in fact we are coming round to an organisation and layout not very dissimilar from that of the old village of the open fields in the days of the manorial system of farming, but with modifications which will permit of the use of modern methods of mechanisation of some of the agricultural operations, with due care for the maintenance of soil fertility and soil conservation and with the retention of the individual cultivator as a shareholder in the agricultural production of the village unit and a security of tenure in respect at least of that part of the village lands where security of tenure is most important.

I should not close this section without referring to the developments which I feel must take place on this re-organised village unit if production is to be stepped up.

As we all know the average area under cultivation per family in the Colonies where hand cultivation is the rule is very limited, for example three to five acres in Nigeria in the groundnut belt, two to three acres under rice in the Malayan paddy fields, &c., and very often the extension of this acreage is impossible because of the bottlenecks in the agricultural calendar, chiefly in the cultivation prior to planting and in the harvesting of the crop, which limit the area which can be handled.

The Colonial Advisory Council of Agriculture, Animal Health and Forestry as a result of a questionnaire recently sent to all Directors of Agriculture have come to the conclusion that mechanisation of agricultural production in the Colonies is an inevitable development, and decided to send out to the Colonies a small mission to examine conditions in typical rural areas and to report on the problems which will arise, social, economic and agricultural if a policy of mechanisation is pursued.

There is no doubt that the people of the Colonies are becoming more and more machine-minded in so far as agriculture is concerned and visits by Chiefs and others to this country have only served to emphasise this desire for mechanisation of agriculture. As to how or in what form mechanisation can be best applied to the life of a village community, whether in actual cultivation of crops, or in processing of crops or in improving water supplies is one of the points which the mission to which I referred just now will no doubt pay attention, but I have little doubt that the peasant farmer in the Colonies is thinking in terms of agricultural tractors and implements as a means of increasing his production and of lightening his labours.

I am satisfied therefore that in developing this group agriculture we must anticipate the increasing use of power-drawn implements in peasant production, and the organisation which I have suggested assumes that this development will form an essential part of the economy of peasant agriculture. Whereas, however, in this country and in most advanced countries the objective is to replace hand labour as far as ever possible by the machine because of the ever increasing demands on labour by industry, in the Colonies, at least until industrial development has reached a stage not at present conceived, our objective must be to assist hand labour with the machine and not to eliminate it, for we are dealing with people already on the land to whom in most cases there is no alternative to agriculture as a means of livelihood.

Our objective should therefore be to analyse the family labour calendar in agriculture and see what bottlenecks in this calendar are the bars to expanded production and to more efficient and even use of the labour available and to develop mechanisation aimed at breaking their bottlenecks.

Our final picture in areas where annual crops are the basis of the agricultural system and where we assume that only half the village land is suitable for arable cultivation will be a density of population something of the order of 50 agricultural families to the square mile plus any other people who go to make up the normal rural population, not a very dense population when we think in terms of the 1,200 to the square mile in parts of the oil palm belt in Nigeria.

In such special areas as the oil palm belt and the cocoa soils of West Africa and the coffee soils of East Africa the problem of group cultivation is not the same as the one I have sketched out but becomes largely a question of consolidation of planting of these perennial tree crops so organised that processing of the crop and possibly modern methods of dealing with pests and diseases can be facilitated and organised as a collective or group activity, as witness the development of the Pioneer Oil Mills in Nigeria, the development of pulping stations in the native coffee areas of East Africa, and in Malaya the possible development of bulk latex collection of small holders' rubber.

Development of the Community

The third point I suggested was the development of a community so as to allow of specialisation within the life of the community and providing scope for the more progressive members of the society to satisfy their ambitions within the community

I suppose division of labour and specialisation are characteristics of a progressive community and if our village community is to be efficient there will be scope for specialisation in the agricultural field in the shape of tractor drivers, stockmen, transport drivers, market clerks, &c., not to mention the

activities of such members of society as the traders, dispensers, schoolmasters, &c., which make up the rural community. For example it is calculated that one ordinary agricultural tractor of the Fordson type with its complement of implements could serve 20 families each with a 30 acre holding. The cattle and other livestock of such a group could be more efficiently looked after and the pasture of the village areas better managed if the livestock of the village were made the responsibility of one or two members of the community knowledgeable in the proper feeding, housing and management of livestock. Under such an arrangement the stock would be more likely to be limited to the carrying capacity of the village pastures than in the case where every individual competes with his fellow villagers for the limited grazing in the village area. In addition, the curing of hides and skins and the preparation of dairy produce, possibly clarified butter, would be better done under such an arrangement.

In touching on land tenure I suggested that a progressive individual in the community should have the right to acquire more than one holding, and it may well be that ultimately with aggregation of holdings a system of large tenants employing some of the other villagers as wage earners would develop. From the agricultural aspect I could see no harm in such a development.

Capital Requirements

Finally I referred to the need for adequate capital resources to enable such a system of group cultivation to be established and to function efficiently.

Modern agriculture as we know it in this country is a highly capitalised industry and becoming more and more so with the increasing demands made upon it. For example when I was a youth a common figure quoted as necessary for an ingoing tenant was in the region of £10 per acre for all live and dead stock and outgoing tenant's valuations. That figure to-day is nearer £30 or £40.

In order to attract capital investment any proposition must normally hold out a reasonable prospect of giving a return on capital, and of course so long as present prices for colonial produce continue there is little fear that capital invested in expanding production and in mechanisation will not give a reasonable return on capital and give an increased cash income to the producer. As to the future nobody can foretell the trend of world prices but the Government of this country and members of all political parties are agreed that long term assurances as to markets and prices are an essential plank in the platform of any agricultural policy for the United Kingdom. Would that such a policy could be extended to include the Colonies, or preferably adopted by the western European nations as a common policy towards the Colonial dependencies of all the metropolitan powers, for there is no doubt that the more agriculture departs from a subsistence economy the less and less is it able to withstand the shocks of price depressions and market slumps which were a feature of the world economy between the two wars. However, I said at the start of my talk that I did not propose to enter into this controversial field, but I must say that in the absence of some assurance in regard to the future I fail to see how the necessary capital will be forthcoming for this, in my view, essential pattern of development in the Colonies if we are to aim at a higher standard of living for the rural peasant and an increasing volume of production and export of primary products needed for the industrial population of western Europe.

Two sources of capital naturally suggest themselves, the Colonial Development Corporation and the individual Governments through loans, probably using the development of co-operative societies amongst the producers as the machinery for their distribution and control ; and I know that the Adviser on Co-operation to the Secretary of State has this very much in mind.

Concluding Remarks

Well, I have sketched fairly briefly the ideas which I believe are increasingly being crystallised in the Colonies as a possible pattern of development and I have no doubt that many of you are thinking—a very pretty picture —but how is it to be brought into being ?

In this I believe, as was expressed by Sir Phillip Mitchell, Governor of Kenya, at a meeting of the African Governors last year, that we shall make little progress by trying to persuade existing complex rural communities in the Colonies to adopt this pattern of development by voluntarily agreeing to a re-organisation of their existing holdings, but that we shall have to set up new communities of this pattern in areas in the Colonies at present uninhabited or sparsely inhabited and demonstrate the actual pattern of development on the ground. In this connection I would refer you to the Report of the West African Oilseeds Mission of 1947, Col., No. 224 in which this conception is more fully discussed and recommended as a means of developing increased production of oilseeds and cereals in West Africa. The recommendations in that Report have been the subject of study and discussion by the West African Governments and the Colonial Development Corporation and I am hopeful that as a result pilot schemes will be established in Nigeria and possibly the Gold Coast.

Were there time, I could tell you about some interesting work being carried out in various Colonies in experiments with mechanisation, in Uganda, in Nyasaland and in Malaya, but I fear I have trespassed on your patience far too long. I would end by stressing that any development of the kind I have suggested is essentially one which calls for the fullest co-operation between the Administrative and the Technical Departments of Governments and is essentially an example of the need for team work in development.

Hence I cannot stress too much the value of the Colonial Service Second Course which brings together officers of the various Colonial services for discussion and consideration of the various aspects of Colonial Administration and Development.

A SHORT HISTORY OF AGRICULTURE IN THE BRITISH COLONIES

By G. B. Masefield. *Oxford Clarendon Press*, 1950. *Pp.* 179. *Price* 10*s.* 6*d.*

Until comparatively recent years literature on Colonial Agriculture has been sadly lacking in comprehensiveness. The British Colonies comprise such a a variety of countries that few writers could attempt much more than a provincial review of a few products or a few countries. The value of any up-to-date book that brings together the whole Colonial Empire cannot be over-emphasised.

The title might possibly have been "A Short *Economic* History", with the emphasis perhaps more on the economics than the history. The first 50 pages are concerned with general historical development, the remainder with the development of services and conditions of particular interest to the agriculturist. This mode of treatment has the great advantage of bringing home clearly the agricultural lessons of history. For instance, monoculture is a system that has advantages and disadvantages whether pursued in Malaya or the West Indies ; the extent and development of this system is more forcefully treated as a chapter of its own than as a feature of the development of either country.

This book will be a boon to students of tropical agriculture in providing them with a wealth of up-to-date information of many aspects of colonial agriculture. It should prove to be a most readable volume for residents of the temperate regions who are curious to know something of the conditions and problems of the other half of the world.—A.L.J.

COLONIAL GOVERNMENT : ANNOTATED READING LIST

By Margery Perham, *Nuffield College, Oxford University Press, London*, 1950. *Pp.* 80. *Price* 4*s.* 6*d.*

This reading list of about 600 items will undoubtedly prove useful to all interested in Colonial affairs. Although, as the title implies, government is the subject matter of the list, most of the items naturally include much more than the bare bones of administration. The list is divided by sections into history, and evolution, into Colonies, both British and foreign, and other headings. The author's descriptions of the most important items are both concise and informative.—A.L.J.

GENERAL AGRICULTURE AND HORTICULTURE

CACAO PRODUCTION OF SOUTH AMERICA

By Ivar Erneholm, *Gottenburg, Sweden*, 1948. *Pp.* X 279. *Price: U.S.* $12.00.

This work, as the sub-title indicates, is divided into two parts, (i) the historical development, and (ii) the present geographical distribution of cacao production in South America. The second part would appear to be the logical development of the first and it is somewhat surprising therefore that the two parts should be quite distinct as to material, treatment and, in the reviewer's opinion, as to merit. To take the second, less meritorious, part first.

Mr. Erneholm's researches have produced some valuable estimates country by country of the geographical distribution of cacao production in South America at the present time. This material would have been most useful if illustrated on a map of the continent instead of being shown in scattered maps (of varying scale with no guide names) for various sections of the continent. A single production map would have formed a concise conclusion of the previous excellent outline of the historical development. The chief criticism, however, is not the lack of co-ordination, but the over-elaborate discussion of local climate conditions accompanied by a superficial description of local geology for each cacao-growing district. If the object of introducing these voluminous observations is to describe fully the conditions under which cacao is actually grown, much more than climate and geology is required : soils, topography, cultural methods, marketing facilities, labour supply and quality, competitive crops, &c., &c., would all require discussion. If the object is to describe limiting conditions for delineating " potential areas " the author could arrive, as in fact he did in the last chapter at his conclusion much more simply. " Escobar de Baja (Witches' Broom disease, *Marasmius perniciosus*) has now spread to almost every part of tropical South America ..... Only in those areas (where there is no Witches' Broom) can one expect any considerable expansion in cacao cultivation ".

The first part of this work is for the English reader a most valuable contribution to the knowledge of the early development of cacao production in South America. The author has by diligent search of a large number of ancient documents produced an authoritative history of cacao from the earliest days. Few English readers, for instance, realise that the cacao boom in Ecuador was spread over the extraordinary period of 100 years, whereas in Venezuela it was a flash in the pan of a mere 20 years duration. The only suggestion for improving this part for the benefit of ignorant readers is that quotations in French, Spanish and Portuguese should be translated into English in footnotes.—A.L.J.

CITRUS PRODUCTS

By J. B. S. Braverman, *Interscience Publishers, Inc., New York*, 1949, *pp.* 424. *Price :* 9 *dollars* (*U.S.A.*).

The author of this practical treatise is director of the Central Citrus Products Research Laboratory in Rehovoth, Israel, and has had twenty-five years of factory experience. The book is divided into two parts ; Part I (140 pp.) deals with the chemistry of citrus fruits, and Part II (218 pp.) deals with technological processes, such as the preparation of the fruit, extraction of essential oils, processing of Citrus juices, concentrating, freezing, sweetening and fermenting juices, and the preparation of various Citrus products, including marmalade, citric acid and pectin, and the utilisation of Citrus peel. The classification and arrangement of the subject matter are both excellent, and the information is clearly set out with full references to the sources of information. There are numerous tables, graphic formulae, diagrams and pictures of apparatus and appliances.

Concerning beverage juice extraction, it is stated that the only acceptable method is hand-reaming the halves, because this procedure does not cause so much contamination by undesirable essential oils and albedo flavours as does the application of mechanical squeezers. This is quite contrary to experience in Trinidad with revolving burrs which are here used for hand-reaming ; mechanical extraction introduced last season proved to be entirely satisfactory, provided the machines were properly set. Furthermore, mechanical juice extractors are almost exclusively used in United States of America where stringent regulations are in force regarding the permissible amount of rind-oil in grapefruit juice. In the same section, the author states that the presence of unbroken pulp-cells in commercial Citrus juices is preferred by the public. Although in some types of juice this may be so, nevertheless, in the case of canned grapefruit and orange juices, most purchasers consider it to be an undesirable feature, and the formation of sediments in these canned juices has to be guarded against by a preliminary fine-screening.

The author considers that de-aeration should invariably be practised prior to pasteurisation in order to prevent oxidation which destroys the flavour of Citrus juices. This is contrary to experience in United States of America and in Trinidad, where grapefruit juice is seldom de-aerated, although orange juice may be so treated because of its more delicate flavour and poor keeping quality.

The basic facts presented in this book, on the whole, seem to be accurate, although the section on the processing of Citrus juices might have been greatly improved had a more critical evaluation of the different processes been offered as a guide to the selection of the best methods.—F.W.A.

THE CLOVE TREE

By G. E. Tidbury. *Crosby Lockwood and Son, Ltd.*, 39, *Thurloe Street, South Kensington, London, S.W.*7, 1949. *Pp.* 212. *Price* 18*s*.

An informative and very readable little book dealing mainly with the cultivation of the clove in the islands of Zanzibar and Pemba. The author, who has been for many years an Agricultural Officer in the Zanzibar Proctorate, has made a detailed study not only of the clove tree but also of its history and the history of the people who have cultivated it so successfully for more than one hundred years. His comprehensive knowledge of the history and agricultural methods of the Arabs of Zanzibar makes the book into an interesting and readable account of a very ancient crop instead of just another botanical textbook.

Although cloves are grown commercially in Zanzibar, Madagascar, Penang and the East Indies and are therefore of little general agricultural interest this book is well worth reading.—R.E.D.B.

EVERGREEN ORCHARDS

By William H. Chandler. *Lea and Febiger, Washington Square, Philadelphia*, 6, *Pa.* 1950. *Pp.* 426 + 66 *Illustrations. Price* $6.

In addition to the commoner tropical orchard crops such as grapefruit, oranges, tea, coffee cacao, bananas, oil palms and coconuts this book contains much valuable information on lesser-known fruit trees. Useful notes will be found on fruits such as the kumquat, bael fruit, soursop, sugar apple, custard apple, guava, sapodilla, star apple and many others.

This book should be of particular interest to students coming to the tropics for the first time and will help them to identify and appreciate the many strange fruits they will see. It is also valuable to the botanist as botanical names are fully and accurately given and often their more important synonyms are discussed. The introductory section, of necessity somewhat sketchy, deals with the orchard environment, manuring, thinning, grafting, planting, pruning, pests and diseases. For those who require more detailed information there is a bibliography containing nearly seven hundred references.

Beautifully printed on excellent paper and well illustrated this book is very good value at $6.00.—R.E.D.B.

VEGETABLE GUMS AND RESINS

By F. N. Howes, *Royal Botanic Gardens, Kew. Chronica Botanica, Waltham*, 1949. *Massachussets, U.S.A.* 1949. *Pp.* XX, 188. *Price U.S.* $5.00.

Agriculturists and others engaged in the cultivation of the major food and industrial crops will often have the haziest ideas about where gums and resins come from ; even those concerned with peasant economics, and the collection of these substances is predominantly a peasant industry, will find much interesting information in this book. It is surprising that, since they are found mainly in tropical and subtropical countries, they are so sketchily dealt with in the teaching of tropical agriculture. The simple, primitive methods used in their collection from wild trees no doubt account to a great extent for this absence of interest.

The physiognomy of the plant communities is shown by a series of forest profile diagrams, and a good idea of their main features may be gathered from the excellent photographs of typical examples. Their floristic composition is indicated by numerous plant lists and by distribution tables and vegetation maps.

The book is full of original observations ; the treatment is broad and strictly ecological ; the presentation is systematic, lucid and interesting ; the printing is excellent, and indeed, in the opinion of the reviewer, the book is a model of what a modern " forestry memoir " should be.—F.H.

A VEGETATION-TYPES MAP OF TANGANYIKA TERRITORY

Bt. Clement Gilman, *American Geographical Society, New York*, 1949. *Reprint from " Geographical Review, Vol.* XXXIX, *No.* 1, 1949, *pp.* 7–37. *Price* 1 *dollar.*

This publication chiefly consists of a beautifully-coloured map, (24 by 24 inches in size, on the scale of 1 to 2 million), 31 photographs, and 31 pages of description. It represents the results of fundamental research in land development, based on knowledge of natural vegation, water resources and soil quality, by one who was eminently suited to the task through his unique personal qualities as a geomorphologist and a student of long standing of East African problems, both geographical, ethnological, botanical and sociological. The source material was collected during railway and hydrographic surveys carried on between 1913 and 1946, during which notes were made of the country traversed, the total distance covered being over 17 thousand miles.

The method used for the classification of the vegetation is physionomic ; the following main types are mapped :—(1) forest, (2) woodland, (3) bushland and thicket, (4) wooded grassland, (5) grassland, (6) permanent swamp vegetation, (7) desert and semi-desert, (8) vegetation induced by man. Pictures of each of these are given in illustration, and each is tersely described in turn. Three distinct recurring sequences (" catenas ") of vegetation have been identified ; they are mapped in vertical coloured stripes. One of them, the central Plateau Catena, covers about one-ninth of the country's surface.—F.H.

SOIL EROSION : ITS PREVENTION AND CONTROL

Issued by the Madras Government ; Government Press, Madras, India, 1948. *Pp.* 184. *Price : 6 rupees.*

This textbook was compiled in 1945 by the departments of irrigation, agriculture, forestry and public health in Madras for the use of departmental officers, under the editorship of L. Venkatakrishnan, Irrigation Engineer. It comprises 18 chapters and 158 pictures, many of which come from American sources. The chief subjects are the causes, results and control of soil erosion, treated in the first 4 chapters, the remaining chapters being devoted to essentially practical subjects like contour bunding, trenching and afforestation, terracing, grass-land conservation, regulation of shifting cultivation on slopes, elimination of gullies, construction of check dams, and special methods for use in the control of river-bank erosion, wind erosion, and floods. The last chapter deals with soil erosion in relation to malaria. There is a rainfall map of India, a long table of monthly rainfall data for the Madras Presidency, a glossary of the names of crop plants, a short bibliography and an adequate index.

There have lately been published a number of books on soil erosion in general but this one stresses mainly the theory and practice of earth-work construction (banks, trenches, terraces, check dams, revetments, &c.) and should therefore prove of special usefulness to engineers and others responsible for the actual control of soil erosion in the field.—F.H.

SOILS : THEIR ORIGIN, CONSTITUTION AND CLASSIFICATION—AN INTRODUCTION TO PEDOLOGY

By G. W. Robinson. *George Allen and Unwin, Ltd. London.* 1949, *Third edition, revised and enlarged. Pp.* 572, *Price* 32*s.*

The appearance of a new edition of Professor Robinson's book is a most welcome event to English reading students of Soil Science who have come to recognise it as a standard work. The new revised edition has grown by about 30 per cent. from 432 to 572 pages, but retains its original arrangement of subject matter. A notable extension and revision is in the section dealing with soil formation where the two aspects of the subject—formation of soil parent material and soil profile development—have been expanded into two separate chapters. The discussion of Mattson's work on isoelectric precipitation is now included in the chapter dealing with weathering and parent material formation, having been removed from the following chapter dealing with the clay complex. The latter section has been largely revised to incorporate the newer knowledge on the structure of clay minerals. Similar revisions have been made throughout the book, as can be seen from the increase in the number of references at the end of each chapter, though the bibliography is, as the author himself states, merely based on personal selection and is not intended

to cover the full scope of any section of the rapidly growing science. While the book is primarily intended as an introduction to Soil Science for the student, embracing geological, geographical and agricultural aspects of the subject, there is enough thought-provoking material to stimulate the much maturer worker. The printing and binding are excellent, except for an occasional misprint, and come up quite close to the standard of the pre-war edition. It is the opinion of the reviewer that the book should maintain a high priority rating among books recommended for the soil specialist as well as for the general agriculturist.—G.R.

STUDENTS HANDBOOK TO FERTILISERS AND SOILS

By L. T. Lowe, (*Monmouthshire Institute of Agriculture*). *Littlebury, & Co. Ltd., Worcester, England. Revised edition*, 1949, *pp.* 111. *Price :* 8*s.* 6*d.*

This book aims at providing concise technical and scientific information for those engaged in training agricultural students. The subject matter therefore is severely condensed but is equally divided between the two subjects. The part about fertilisers is admirably presented. The second, concerning soils, is perhaps not so satisfactory though admittedly the subject is difficult to deal with in such small compass. To the average non-specialist student, however, this section should convey about as much as he would need to know for practical farming, and at the same time, indicate the difficulties which beset the advisory chemist in connection, for example, with soil analysis. The last part of the book contains notes on the meaning of pH and pF, an extract from the Fertilisers and Feeding Stuff Act controlling the sale of fertilisers, and a brief index. This book can be strongly recommended.—F.H.

COMMUNICATIONS ON ORIGINAL INVESTIGATIONS

ARMILLARIA ROOT AND TRUNK ROT OF OIL PALMS IN THE BELGIAN CONGO

By

C. W. WARDLAW

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Author's Summary

A Brief account is given of the origin, occurrence and symptoms of the Armillaria root and trunk rot of oil palms in the Belgian Congo.

I—Introduction

During recent years a disease of plantation palms (*Elaeis guineensis*) has become conspicuous in the region lying between Bumba and Stanleyville on the main river in the Belgian Congo. This is a root and trunk rot caused by the widely distributed fungus *Armillaria mellea*, Vahl. In some plantations the incidence is still very slight, but in others the disease has made rapid progress in the past 2-3 years. The distribution of this disease in the palm-growing regions of West and Central Africa has yet to be determined ; plantation authorities should certainly be on the look-out for it. Studies of the early stages of infection and related environmental factors and a search for preventive measures are urgently required.

This disease was first observed by Dr. Steyaert of the I. N. E. A. C., Yangambi in 1944. More recently Dr. Moureau (also of the I.N.E.A.C.) has made a valuable and timely contribution to our knowledge of this disease, a severe outbreak in some of the Yangambi blocks affording abundant material for his investigations. I am indebted to him for some of the information set out below. The main purpose of the present short report is to illustrate some of the more evident features of this remarkable disease.

II—Occurrence

The disease may occur on all soil types but palms on poor, sandy soils are most rapidly destroyed ; on these, the damage caused by Armillaria can be very severe indeed. An outstanding feature of this disease is the speed with which palms are killed, considerable gaps in plantations becoming evident in the course of 2–3 years. Infected palms usually occur in groups, 3–6 dead or dying palms indicating a locus of infection which may extend to many others.

III—Symptoms

The disease has been observed in palms from 4–10 years of age. Older palms are said to be less susceptible or even not affected. The external symptoms include chlorosis and the wilting and breaking of leaves, in fact, effects very like those of vascular wilt disease (Wardlaw, 1950). An early external symptom is that the lowermost leaf-bases become rotted and are easily dislodged from the trunk, Fig. 1 : within the base of the trunk a rapid soft rot of the tissues takes place ; it progresses across the base of the trunk

and upwards into it so that the aerial part of the palm is more or less effectively cut off from the root system. In some instances the rotting proceeds up the centre of the palm. It is a remarkable fact that in some palms the leaves were still of a full green colour and apparently normal although the base of the trunk was almost rotted through. But in such palms disease symptoms sooner or later become evident and the plant quickly dies. The disintegration of the tissues is so complete that the whole system of leaves and trunk collapses and soon disappears under the spreading cover crop, the final effect being one of complete *debacle*, Fig. 2. The rotting of the trunk-base may be unilateral, general, or central and is frequently but not invariably attended by an unpleasant odour. Some stages of the penetration and rotting of the trunk are illustrated in Figs 3 and 4. Infected tissue passes through a yellowish-brown stage with intermingled white plates or strands of matted fungal filaments (rhizomorphs), as shown in Fig. 3. From such a lateral infection the fungus extends its filaments and rhizomorphs in finger-like processes into the softer, inner tissues of the trunk, Figs. 3 and 4. A typical black streaking of the vascular strands in proximity to these regions of mass infection is a conspicuous feature. The dark colouration was observed to be associated with the *fibre*, and not the wood vessels as in vascular wilt disease. In some specimens, as the infection spread inwards, the soft parenchymatous tissue was completely destroyed leaving a cavity filled with the remains of the fibrous vascular strands. Other micro-organisms and animal agencies may perhaps be associated with this condition

The mushroom-like fructifications (sporophores or carpophores) of the fungus are abundant on the trunk, near the ground, during the wet season, Figs. 1, 5 : they are scarce during the dry season but a few may be observed. They occur in clusters, are of a honey colour, and have a well-marked ring on the stalk or stipe, Fig. 5.

In some palms the fungal lesion at the base of the trunk remains localised, dries up and is apparently sealed off from the healthy tissue within. Above such a canker a mass of new roots grows down. In these instances rotting is apparently limited by the inherent resistance of the palm or by other conditions. More precise knowledge of this phenomenon may prove of practical importance. So far, the disease has been observed on *Tenera*, *Dura* and sterile palms and on palms regarded as being of the Deli type.

IV—Source of Infection

Dr. Moureau has made the interesting observation that the incidence of this disease is much higher on burnt than on unburnt areas. He has also been able to show that the disease originates in the old infected stumps of certain forest species. The fungus passes by way of the decaying roots of the stumps to the roots of the adjacent palms. The rhizomorphs of the fungus invade and exploit the cortex of the palm root and pass into the cortex at the base of the trunk. Only a few roots may be attacked. In these the cortical tissue is typically replaced by matted fungal hyphae or rhizomorphs. The rhizomorphs then spread around the trunk, causing rotting and eventual dislodgment of the leaf-bases, and an inward and upward rotting of the trunk tissues. Various other systems of infection and penetration are also possible.

Note :—The rhizomorphs are branched, thread-like structures visible to the naked eye and consisting of massed filaments of microscopic dimensions.

Fig. 1.—Base of oil palm showing the dislodged leaf bases (arrows) and the carpophores (C) or mushroom-like fructifications of *Armillaria mellea*.

FIG. 2.—Final collapse of a palm killed by *Armillaria mellea*.

Fig. 3.—Detailed study of the rotting produced by Armillaria at the base of a palm trunk. The tissue on the left is becoming thoroughly rotted and is penetrated by thick white mats or wefts of fungal mycelium (rhizomorphs). From the margin of this region of mass decay finger-like regions of decay are penetrating inwards. Darkening of vascular strands in proximity to the diseased tissue is evident.

Fig. 4.—Further evidence of the penetration of Armillaria into the central region of the trunk. Note the numerous darkened vascular strands.

Fig. 5.—A typical cluster of the fructifications or carpophores of *Armillaria mellea* on a decaying leaf-base.

V—Mixed Infections

As I pointed out in an earlier paper (Wardlaw, 1950) the disease situation in oil palms tends to be complex. In investigations of Armillaria trunk rot the same difficulty has been experienced. For example, a palm was found with wilted and broken leaves, symptoms which might lead to a diagnosis either of vascular wilt disease (caused by *Fusarium oxysporum*) or of Armillaria trunk rot. In fact, on dissecting the trunk, both diseases were found to be present. Again, the falling of the lowermost leaf-bases has been regarded as a fairly definite symptom of Armillaria trunk rot. But many palms have been observed with this feature which yielded no evidence either of the characteristic trunk-rotting, as described above, or of the presence of carpophores. A number of fungal organisms may, in fact, be involved in the rotting of the trunk or the leaf-bases.

Until the situation has been clarified by further research it would be wise to suspend judgment and not to regard all basal trunk rots of young palms (up to 12 years old) as being due to Armillaria.

VI—Control

Measures which may be effective in attempts to combat this disease include the following : (i) a thorough inspection of all plantation palms, with a view to the early detection of the disease ; (ii) observation of old forest stumps which harbour, or may harbour, *Armillaria*, and their elimination by appropriate means ; (iii) removal of infected leaf-bases and opening the infected areas to light ; (iv) application of fungicides and possibly of wound-healing agents ; (v) immediate felling of trees which cannot be saved as the *Armillaria* in them is apparently soon killed or depressed by secondary organisms ; (vi) ditching may be resorted to in some instances in order to prevent the spread of the pathogen (the value of this remains to be seen) : (vii) clean weeding round palms to facilitate both inspection and treatment.

Acknowledgments

I should like to express my thanks to Messrs. the United Africa Company, London, for making possible my visit to the Belgian Congo, and to Dr. Moureau of the I.N.E.A.C., Yangambi, and to Mr. W. G. Kovachich who materially assisted me in this work.

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THE EFFECT OF RIDGING ON EASE OF HARVEST, ROOT DISTRIBUTION, AND TOXIC CONSTITUENTS OF *DERRIS ELLIPTICA*

By

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Author's Summary

A Summary of the data shows that : (1) The root yields of *Derris elliptica* Changi III MG 6 grown on level, 8- and 16-ridged plots were essentially the same ; (2) about 95 per cent. of the total weight of root was found in the top 18 inches of soil, irrespective of treatment ; (3) harvesting the roots of plants grown on ridges was easier than on level ground ; (4) harvesting by tractor and plow was from 3 to 4 times faster than digging manually, however, only 75 per cent. of the roots were recovered ; (5) all chemical and biological toxicity values decreased as the height of the ridge increased ; (6) red-color values of the root sub-samples increased with the depth of the excavated soil layer ; (7) total chloroform extractives decreased as the diameter size increased for all treatments ; (8) the treatments produced a characteristic distribution by diameter groups ; the plants growing on the ridges had more large (10+ mm.) and fewer medium (4–10 mm.) and small (under 4 mm.) roots than those grown on level ground.

Introduction

One of the most tedious and costly operations in the commercial production of *Derris* has been the manual digging of the roots. It can be economically harvested by hand only where labour is extremely cheap. It was suggested that the plants be grown on ridges similar to those used in sweet potato culture, to simplify harvesting since it had been shown previously (2) [1] that over 80 per cent. of the roots occur in the top 16 inches of soil. An experiment was started in August 1945 to determine the effect of ridging on ease of harvesting, root development, and insecticidal constituents of the roots.

Experimental Procedure

Three types of plots were used : (1) Level ground that served as a control and (2) ridges that were 8 inches high, and (3) 16 inches high. Both types of ridges were 18 inches across at the base. Each plot consisting of three rows 24 feet long and 3 feet apart, was replicated six times. Twelve 3-month-old rooted cuttings of *Derris elliptica* (Wall.) Benth. Changi III clone MG 6 were planted in each row. The two outside rows of plants and the two end plants of the experimental row of each plot served as a perimeter border.

[1] Figures in parenthesis refer to " Literature Cited ".

The plants that died soon after transplanting to the field plots were replaced to obtain a more uniform stand. No other care was given these plants except to weed the plots from time to time. The vegetative growth of the plants was characterized by sparse foliage and the long bare shoots or vines similar to those of the other MG clones (3) grown at this station.

The harvest made 30 months after planting was sub-divided into three phases. First, the three centre plants of each experimental row were carefully dug by spading out four successive 6-inch soil layers to determine the effect of the treatments on root distribution and size. An area 6 feet long and 3 feet wide, 1½ feet on each side of the plants, was excavated in each plot. The successive depths were measured from the tops of the ridges, or the centre of the row. The time required to dig was not recorded because this operation was necessarily slow and tedious. Second, the remaining plants in the experimental rows were spaded out as rapidly as possible. A set pattern of excavation was not followed but each plant dug in such a manner that essentially all of its roots were recovered. Six men were assigned to this job, four to dig, and two to help pull out and gather the roots. No change was made in their job assignments throughout. The actual time spent in digging each row was recorded for all replicates. Third, all of the border plants were dug using a model C Allis Chalmers tractor with attached 12-inch moldboard plow. Six men using forks and rakes picked up the roots as they were plowed out. The total time required to plow and recover the roots for each row was recorded.

Regardless of the method of harvest all roots were washed soon after they were dug and sub-divided into groups according to three diameter sizes : (*a*) under 4 mm., (*b*) between 4 and 10 mm., and (*c*) over 10 mm. The individual samples were then placed in screen baskets and dried in the sun until they were snap dry. Both fresh and air-dry weights of all the samples were recorded. Later the roots were ground through a 0.5 mm. screen in a Wiley mill and stored for chemical and biological analyses.

Results and Discussion

The data obtained by removing the roots from the four successive 6-inch soil layers are presented in Table I. These data show that the ridging treatments had little effect on the root distribution by depths. The percentage of roots found in the top 18 inches of soil were 96.1, 94.0, and 95.1 for the level, 8-inch, and 16-inch ridge, respectively. In a previous experiment only 81 per cent. of the roots of Sarawak Creeping were found in the top 16 inches of soil which indicates that the MG clones are a more shallow rooted variety.

There was a definite trend among the treatments as to the distribution by diameter groups. The plants grown on both the 8- and 16-inch ridges had more large-sized (10+ mm.) roots and fewer medium (4–10 mm.) and small (under 4 mm.) roots than did those grown on the level plots. Although the average root weight per plant grown on the level was greater than those of the ridged plants it was not statistically significant.

TABLE I. *The average root weights* [1] *of each of three diameter groups found in successive 6-inch soil layers and yield per plant of* Derris elliptica *Changi III MG* 6

(air-dry basis)

Treatment	Depth	Weight by diameter groups			Totals by 6-inch Layers	
		Under 4 mm.	4-10 mm.	Over 10 mm.	Weight	Percentages
	Inches	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Per cent.*
Level	6	10.1	34.5	18.1	62.7	61.7
Do.	12	4.6	18.0	4.0	26.6	26.2
Do.	18	2.1	6.2	0	8.3	8.2
Do.	24	1.2	2.8	0	4.0	3.9
Total ...		18.0	61.5	22.1	101.6	100.0
8-inch ridge ...	6	5.3	23.9	19.8	49.0	57.2
Do. ...	12	5.5	13.7	4.1	23.3	27.2
Do. ...	18	2.3	5.7	0.3	8.3	9.6
Do. ...	24	1.8	3.3	0	5.1	6.0
Total ...	—	14.9	46.6	24.2	85.7	100.0
16-inch ridge ...	6	4.6	24.4	23.5	52.5	58.8
Do. ...	12	4.6	14.8	2.9	22.3	25.8
Do. ...	18	2.2	5.6	1.2	9.0	10.5
Do. ...	24	1.3	2.4	0.5	4.2	4.9
Total ...	—	12.7	47.2	28.1	88.0	100.0

[1] Based on six replicates of three plants each.

Table II presents the average root weight per plant of each treatment dug manually contrasted with those harvested with a plow. The yields of the roots harvested manually represent the average of all of the experimental plants. These values were obtained by combining the total weights of the first two phases of the harvest and dividing by the total number of experimental plants. There was no statistically significant difference in yield among the treatments although the plants grown on the 16-inch ridge gave the highest yield. Although not statistically significant, there was a definite trend in the

distribution by diameter groups. The ridged plants again had more of the large diameter roots and fewer of the medium and small ones, than did those grown on level ground.

TABLE II. *A comparison of harvesting methods on the root yields and rate of harvest of* Derris elliptica *Changi III MG* 6.

(air-dry basis)

Treatment	Method of harvest	Weight by Diameter Groups			Yield per plant	Loss from plowing	Rate of harvest fresh root per man-hour
		Under 4 mm.	4–10 mm.	Over 10 mm.			
		Gm.	*Gm.*	*Gm.*	*Gm.*	*Per cent.*	*Pounds*
Level ...	Manual	16.1	51.2	20.6	[1] 87.9	—	0.37
8-inch ridge ...	do.	14.0	46.9	26.4	87.3	—	.45
16-inch ridge ...	do.	14.0	49.0	33.5	96.5	—	.60
Level ...	Plow	11.6	36.5	18.0	[2] 66.1	24.4	1.7
8-inch ridge ...	do.	9.5	34.1	25.2	68.9	21.0	1.8
16-inch ridge ...	do.	9.0	34.0	28.0	71.0	26.4	1.9

[1] Average based on 6 replicates of approximately 8 plants each.
[2] Average based on 6 replicates of approximately 20 plants each.

Since there was no significant difference in yield among the three treatments it was assumed that the yield from the border rows would be essentially the same as the experimental rows. Calculated from the actual yields there was a decrease of about 25 per cent. in root recovery when the plants were harvested by plow. The data show that a larger percentage of the medium and small roots were lost. This is to be expected because the depth of the plow furrow did not exceed 8 or 10 inches, and the data in Table I show that only a small amount of large roots occur below this depth. The recovery of about 75 per cent. of the roots is in agreement with previous plowing trials made at this station and slightly lower than the recoveries reported * in Ecuador where a whirlwind terracer was used to dig the roots. The effect of the ridging on the distribution by diameter groups followed the same pattern of having more large and fewer medium and smaller roots.

The roots grown on the ridges were much easier to harvest manually than those grown on the level plots. This is shown by the rate of harvest expressed in pounds of fresh root dug per man-hour in Table II. Harvesting by plow was more rapid and the rate of nearly 2 pounds of root per man-hour was almost identical for all three treatments. It is believed that the rate of harvest by plow and tractor would be more efficient if used on commercial plantings. The extremely short rows and alternate level and ridged plots were a definite handicap in harvesting these experimental plants. More than half of the time was spent in manoeuvering the plow into position.

* Private communication from Dr. Lee Hines, Director, Estacion Experimental Agricola del Ecuador, Quito, to Mr. R. H. Hageman. January 3, 1949.

The chemical and biological toxicity values presented in Table III represent all the experimental plants. The standard methods were used to determine rotenone (1), red-color value (4), transmittance (7), and total chloroform extractives (8). The biological toxicity expressed as rotenone equivalent was determined by the "guppy" method (5). By all assays the toxicity was inversely proportional to the height of the ridge. The roots grown on the level were better in all chemical assays by high significance than those grown on the 16-inch ridge. Although not statistically significant the rotenone equivalent, determined biologically, followed the same trend.

Each of the three diameter groups of the three treatments were assayed for their total chloroform extractive content. The average values of the replicates are presented in Table IV. The decrease in the extractive values with the increase in root diameter is quite pronounced and in close agreement with previous assays (6) of similar diameter groups of this same variety. The calculated percentage of extractives of the entire root system follows the same pattern and is nearly identical with the actual assays presented in Table III. The calculated values for the level, 8- and 16-inch ridges are 15.7, 14.5, and 12.5 per cent. respectively, compared to 15.6, 13.9, and 12.9 per cent. obtained by actual assay of the samples composited proportionally to represent the complete root system.

TABLE III. *The effect of ridging on the chemical content and biological toxicity of* Derris elliptica *Changi III MG* 6

Treatment	Rotenone [1]	Red-color value [2]	Transmission	Total chloroform extractives [3]	Rotenone equivalent
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Level	6.6	13.6	63.2	15.6	11.6
8-inch ridge	5.9	11.5	69.0	13.9	11.1
16-inch ridge	5.2	11.2	71.3	12.9	9.7

[1] Differences between rotenone percentages greater than 0.9 per cent. are significant at odds of 99: 1.

[2] Differences between red-color value greater than 1.8 per cent. are significant at odds of 99:1.

[3] Differences between total chloroform extractives greater than 2.1 per cent. are significant at odds of 99:1.

TABLE IV. *Comparison of total chloroform extractives found in the three root diameter groups of* Derris elliptica *Changi III MG* 6 *grown on ridged and level ground*

Treatment	Total chloroform extractives by three diameter groups			Calculated T.C.E. value for the entire root system [1]
	0–4 mm.	4–10 mm.	10+mm.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Level	17.8	16.8	11.6	15.7
8-inch ridge ...	16.5	16.0	10.8	14.5
16-inch ridge ...	15.5	14.3	9.0	12.6

[1] Calculated by dividing the sums of the three products of the actual root weight of each of the three diameter groups and their respective percentages of total chloroform extractives by the total root yield.

The red-color value was determined for each root sub-sample obtained by spading out the four 6-inch soil layers. Because of the small weight of sample available it was impossible to assay by all chemical methods. The average red-color values of the six replicates are presented in Table V. The red-color value of the roots grown in the first 6-inch soil layer of all treatments is much less than that found in the roots of the lower three depths. Other experiments (6) have shown that the percentage of red-color value increases inversely with the diameter size of the root. The data in Table I show that over 82 per cent. of all 10+ mm. diameter roots occurred in the top 6-inch soil layer. It is also evident that the total weight of root of each depth layer was composed of different proportions of the three diameter groups. The low percentage of red-color value of the roots in the top layer can be explained by the fact that approximately 1/3 of these roots were over 10 mm. in diameter. The variations in red-color value with depths is associated with the proportional weights of the diameter groups in each soil layer.

TABLE V. *The variation of the red-color value of* Derris elliptica *Changi III MG 6 roots with depth (6 replicates of 3 plants each)*

Treatments	Depth [1]			
	6-inch	12-inch	18-inch	24-inch
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Level	12.9	15.0	15.6	15.6
8-inch ridge	11.2	13.2	14.3	14.4
16-inch ridge	10.5	14.5	14.4	15.4

[1] Differences among depths greater than 1.5 per cent. are significant at odds of 99:1.

No differences in the growth characteristics of the root systems during harvest were observed. The data shown in Table VI indicate, however, that there was a difference among the treatments in the distribution by diameter groups. There was a definite tendency for the plants grown on the ridges to have a higher percentage, on a weight basis, of the large diameter sizes and a lower percentage of the medium and small roots. This characteristic distribution was found in all three phases of the harvest and is believed to be the reason for the decrease in chemical and toxic constituents in the roots (Table IV) due to the ridging treatments. It is an accepted fact that the large roots of *Derris elliptica* Changi III MG are lower in toxicity values than the medium and small roots. Thus any entire root system having a higher percentage of large roots would have lower assay values. It is believed that the higher soil temperature and better drainage of the ridged plants caused them to grow larger tap roots and to branch less thus changing the root distribution by diameter groups.

TABLE VI. *The effects of ridging on the root distribution by diameter groups of* Derris elliptica *Changi III MG 6*

Treatment	Harvest method	Percentage of total root yield in each of 3 diameter groups		
		Under 4 mm.	4–10 mm.	Over 10 mm.
		Per cent.	*Per cent.*	*Per cent.*
Level	Manual ...	17.7	60.5	21.7
Do.	do. ...	18.3	58.3	23.5
Do.	Plow ...	17.3	54.5	28.3
Mean		17.8	57.7	24.5
8-inch ridge ...	Manual ...	17.4	54.5	28.2
Do.	do. ...	16.0	53.7	30.2
Do. ...	Plow ...	13.8	49.5	36.6
Mean		15.7	52.5	31.7
16-inch ridge ...	Manual ...	14.4	53.6	32.0
Do. ...	do. ...	14.5	50.8	34.7
Do. ...	do. ...	12.7	47.9	39.4
Mean		13.9	50.8	35.4

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A UNIFORMITY TRIAL WITH SWAMP RICE

By

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Author's Summary

As a preliminary to a programme of experimental field work with swamp rice in Trinidad, a uniformity trial was carried out on the newly developed Experimental Rice Plots of the Department of Agriculture at St. Augustine.

A quarter acre field of rice was harvested in small plots as a uniformity trial.

The decrease in standard error with increasing plot size has been demonstrated.

The plot size and number of replications necessary to show any expected significant difference between treatment means can thus be determined.

Experimental Work

The $\frac{1}{4}$ acre field used for the trial had been reformed from a series of small plots individually bunded. The bunds were knocked down in the dry season and the area ploughed, harrowed and levelled with an Adams grader. It was then reploughed and harrowed in preparation for the trial.

Seed of the local variety Joya was sown in a nursery on 3rd June, 1947, and the seedlings transplanted to the field on 30th June. The spacing was 12 inches square with 2 or 3 seedlings per hole. Fertiliser at the rate of 1 cwt. per acre each of ammonium sulphate and superphosphate was applied 6 days after transplanting.

The field was divided into 6 × 8 individual plots each 15 ft. by 13 ft. i.e., $\frac{1}{223}$ acres, and these were harvested separately on 10th-12th November.

Analysis of Data

Five different randomised block layouts were superimposed on the 48 plot as shown in Table I.

Table I

Plot Size	*Layout*
15′ x 13′ = 1/223 acre	4 randomised blocks with 12 plots
15′ x 26′ = 1/112 acre	4 randomised blocks with 6 plots
15′ x 39′ = 1/74 acre	4 randomised blocks with 4 plots
30′ x 26′ = 1/56 acre	4 randomised blocks with 3 plots
30′ x 39′ = 1/37 acre	4 randomised blocks with 2 plots

Each layout consisted of the same four blocks so that the block variance eliminated in each Analysis of Variance was the same. No imaginary treatments were used, all the residual variance after removing block variance being used for the calculation of the standard error.

The Analysis of Variance for each layout is given in Table II and from this the standard error corresponding to each plot size has been calculated.

TABLE II. *Analyses of Variance*

Size of Plot		Degrees of freedom	Sums of squares	Variance	S.E. Mean
1/223 acre	Blocks ...	3	136		
	Residual ...	44	224	5.1	2.26
	Total ...	47	360		
1/112 acre	Blocks ...	3	272		
	Residual ...	20	172	8.6	2.93
	Total ...	23	444		
1/74 acre	Blocks ...	3	407		
	Residual ...	16	148	9.25	3.04
	Total ...	19	555		
1/56 acre	Blocks ...	3	544		
	Residual ...	8	163	20.4	4.51
	Total ...	11	707		
1/37 acre	Blocks ...	3	815		
	Residual ...	4	55	13.8	3.63
	Total ...	7	870		

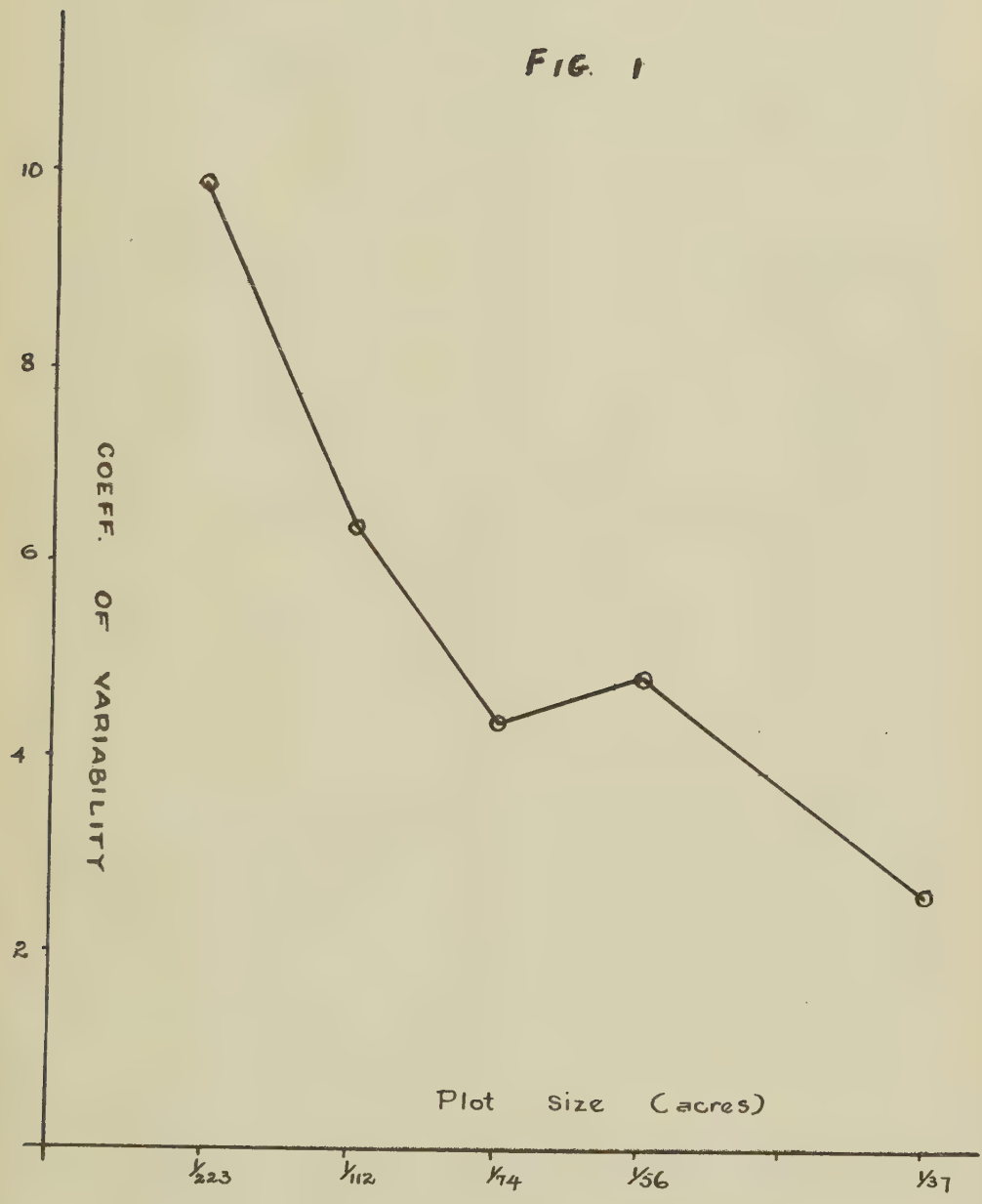
In Table III these standard errors are expressed as percentages of the mean plot yields (coefficient of variability).

TABLE III

Plot size (acres)	1/223	1/112	1/74	1/56	1/37
Mean yield per plot (lb.)	22.9	45.8	68.8	91.6	137.5
Coefficient of variability	9.9	6.4	4.4	4.9	2.6

The relation between plot size and coefficient of variability is shown graphically in Figure I. The diminution of standard error with increasing plot size is to be noted though it would have been preferable to have had a greater range of plot sizes to ensure a smoother curve.

FIG. 1


10
8
6
4
2
COEFF. OF VARIABILITY
Plot size (acres)
1/223
1/112
1/74
1/56
1/37

In the analysis no attention has been given to plot shape but the lower coefficient of variability of the 1/74 acre plots as compared with the 1/56 acre plots can probably be attributed to this. The former is a plot nearly 3 times as long as broad whereas the latter is nearly square. In general, a narrow plot gives a more efficient control of plot variability in a field trial than a square one.

The results can now be used to determine the minimum number of replications necessary to demonstrate significant treatment differences at the 5 per cent. point which was the practical object of the uniformity trial. The significant differences between treatment means expressed as percentages of the general mean for varying number of replications are given in Table IV.

Table IV

Plot sizes (acres)	Replications	Significant differences between treatment means
1/223	4	19%
	5	16%
	6	14%
1/112	4	12%
	5	9%
	6	8%
1/74	4	9%
	5	7%
	6	6%
1/56	4	10%
	5	8%
	6	7%
1/37	4	6%
	5	5%
	6	4%

For preliminary trials where a 10 per cent. significant difference is sufficient, plots as small as 1/112 acre with 5 replications would be sufficient. For smaller differences larger plots and more replications would be required but any trial will need to be judged on its own merits. In general a plot size of between 1/40 and 1/80 acres is a convenient size and under similar conditions to this trial a significant difference between treatment means of 6 per cent. could theoretically be demonstrated with 4 replications of the larger plots or 6 replications of the smaller.

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THE USE OF CLIP-CARDS IN AGRICULTURAL RESEARCH

By

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Author's Summary

Some applications of a manual card sorting system are dealt with in this article. The advantage of the manual over the mechanical system is chiefly one of cost. Much research in agriculture is carried out on comparatively small stations, which cannot afford mechnical equipment ; the varied and often seasonal nature of much agricultural data exaggerates these difficulties.

These cards have been used in the Economics Department of the College for the past 10 years. Their application to cocoa field experiments and peasant surveys is described in detail ; other applications mentioned are farm accounting, soil analyses and marketing reports.

The findings about the system are discussed. The chief of these is that the apparent disadvantages appear to the uninitiated much greater than they actually prove to be, and the advantages much less obvious than they are in practice.

Introduction

Most agricultural scientists, whether specialising in botanical, economic, chemical and other research, are aware that punch and clip-cards are extensively used in various branches of industry and science. Comparatively few, however, have had practical experience in the use of cards in their own line of work and often do not fully realise the convenience of them. The system of clip-cards* discussed in this article was used as an experiment in the Economics Department of the Imperial College in 1940 ; since then the system has been applied to a successively wider variety of data until at the present time it has become routine to handle all data requiring analysis on clip-cards.

Few agricultural research centres can carry the range of equipment required to make full use of punch-card systems.† It is typical for agricultural research to be carried out on isolated experimental farms and for much of it to consist of comparatively small (from a statistical point of view) and seasonal projects. These conditions favour a system of decentralised recording and analysis that requires little equipment and technical knowledge. With the clip-card system the worker can, at the sacrifice of some of the labour saving of punch-card sorting and tabulating machines, enjoy the benefits of a sortable card system with negligible expenditure on equipment.

* " Paramount ", " Kwiksort ", &c.

† Hollerith, Powers Samas, I.B.M., &c.

The clip-card system consists of a card perforated round the perimeter so that a sorting needle can be inserted through a pack. The identification of coded information is achieved by cutting a V-shaped slot with a pair of hand clippers over the applicable perforation ; when the needle is inserted through that perforation and the pack of cards is raised the clipped cards fall out of the pack. Besides needle sorting, this system automatically creates a visible index of cards ; the V-shaped clips are easily recognisable in a pack of cards arranged systematically in a filing drawer and can, with a little practice, be identified by inspection (Fig. 1).

Considerably more information than would at first be supposed can be clipped into a card. The " general " card (Fig. 4) used in this department measures $6'' \times 8\frac{1}{2}''$ (about half of a sheet of foolscap) and carries 112 clippable perforations. This card can be clipped in many million different ways (actually 10^{33}), or can carry as many as 28 different classifications of 16 classes each. There are various methods of combinational clipping designed to economise in the perforations required ; the factorial method was originally adopted in this department for all quantitative data and has proved satisfactory. This method consists of numbering the perforations 1, 2, 4, 8,.....&c., and identifying any quantity (say, 7) by a combination of clippings that add up to the required number (1+2+4=7). When numerous classes, such as serial numbers, are to be identified the factorial codings, 1, 2, 4, 8 are repeated for units, tens, hundreds, &c.

A great advantage of the clip-card system for the comparatively isolated research worker is that the essential equipment consists of only one sorting needle and one pair of hand clippers. The cost of the cards varies with the size and quality of board and the volume of the order, but they are not much more expensive than an equivalent order of plain cards. The cards are manufactured to the user's design and can, for practical purposes, vary in size from 18 to 170 perforations. The cards are manufactured in different colors in various board weights.

Specimen Data

(*a*) *Cacao experiments*—The first application of the system at the Imperial College was for recording individual tree yields in cacao fields. The design of card (Fig. 2) has proved to be by no means perfect but has been sufficiently satisfactory to be in continuous operation for ten years ; it has served to record and analyse about a quarter million tree yields with very little labour by comparison with sheet recording and analysis which was previously practised. Each card refers to a tree site which carries a serial number ; this number is clipped in groups of ten to allow the cards to be re-sorted back into serial order when a new year's yields are to be entered. The serial numbers were identified down only to groups of ten because it is easier to sort the individual ten cards groups by hand than by needle. If the arborial occupant of the site does not change within certain prescribed limits during the ten-year period the one card can carry all the information for that period, since certain particulars about site will be repeated for each of the ten years and can be shown as one permanent clipping on the card. These particulars consist of : (*a*) type of planting material, (*b*) parentage, (*c*) size of pod (*d*) composition of tree (chiefly number of trunks), (*e*) age of tree measured, on the base year, 1950/51, (recently moved forward to 2000/01) and (*f*) other

FIGURE 1

NEEDLE SORTING TO PRODUCE A VISIBLE INDEX

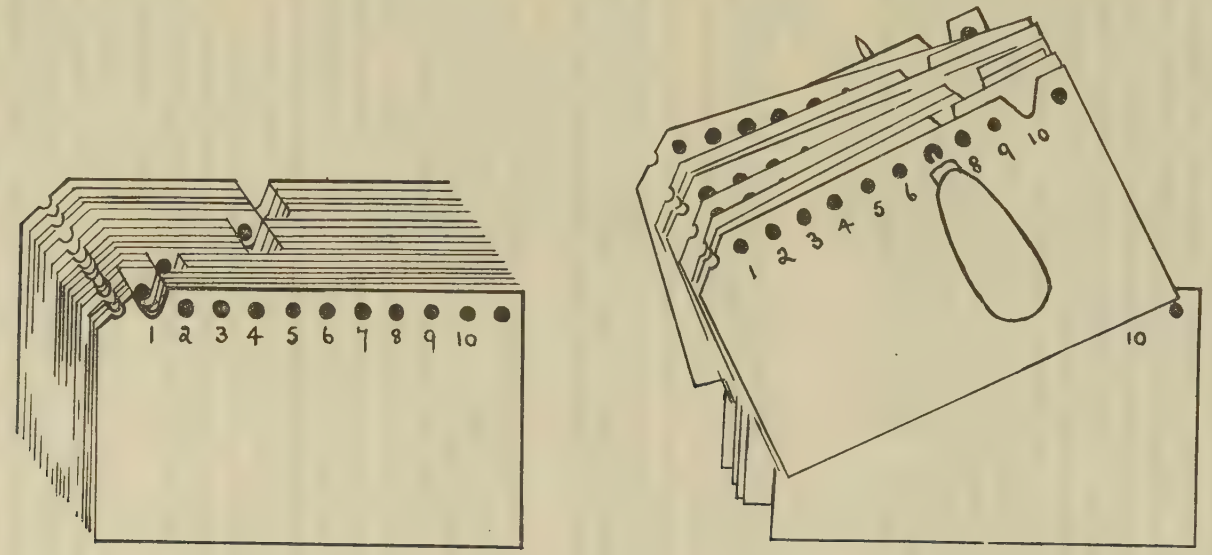


FIGURE 2

ORIGINAL CACAO CARD

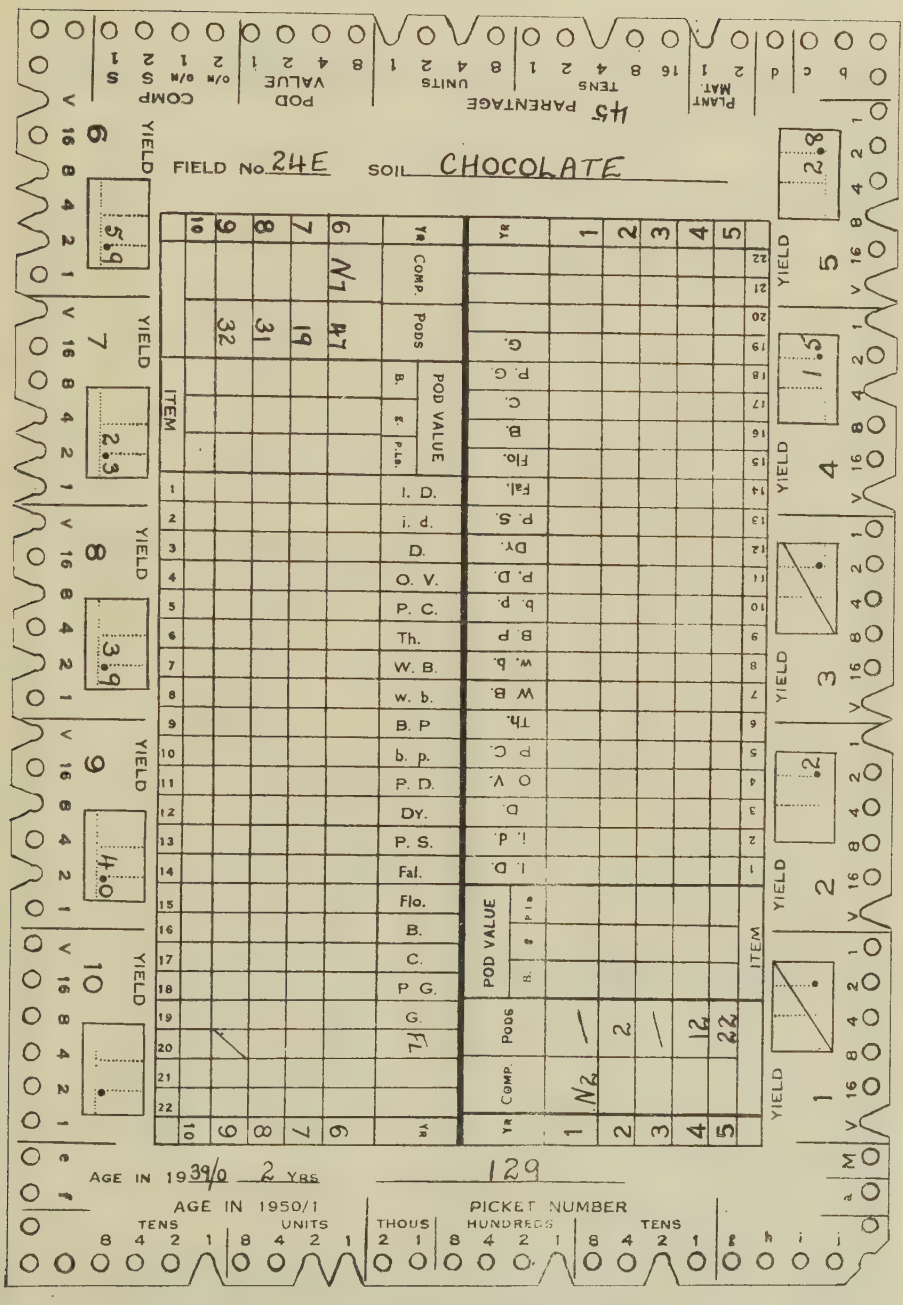


FIGURE 3

CACAO CARD FOR FIELD EXPERIMENTS

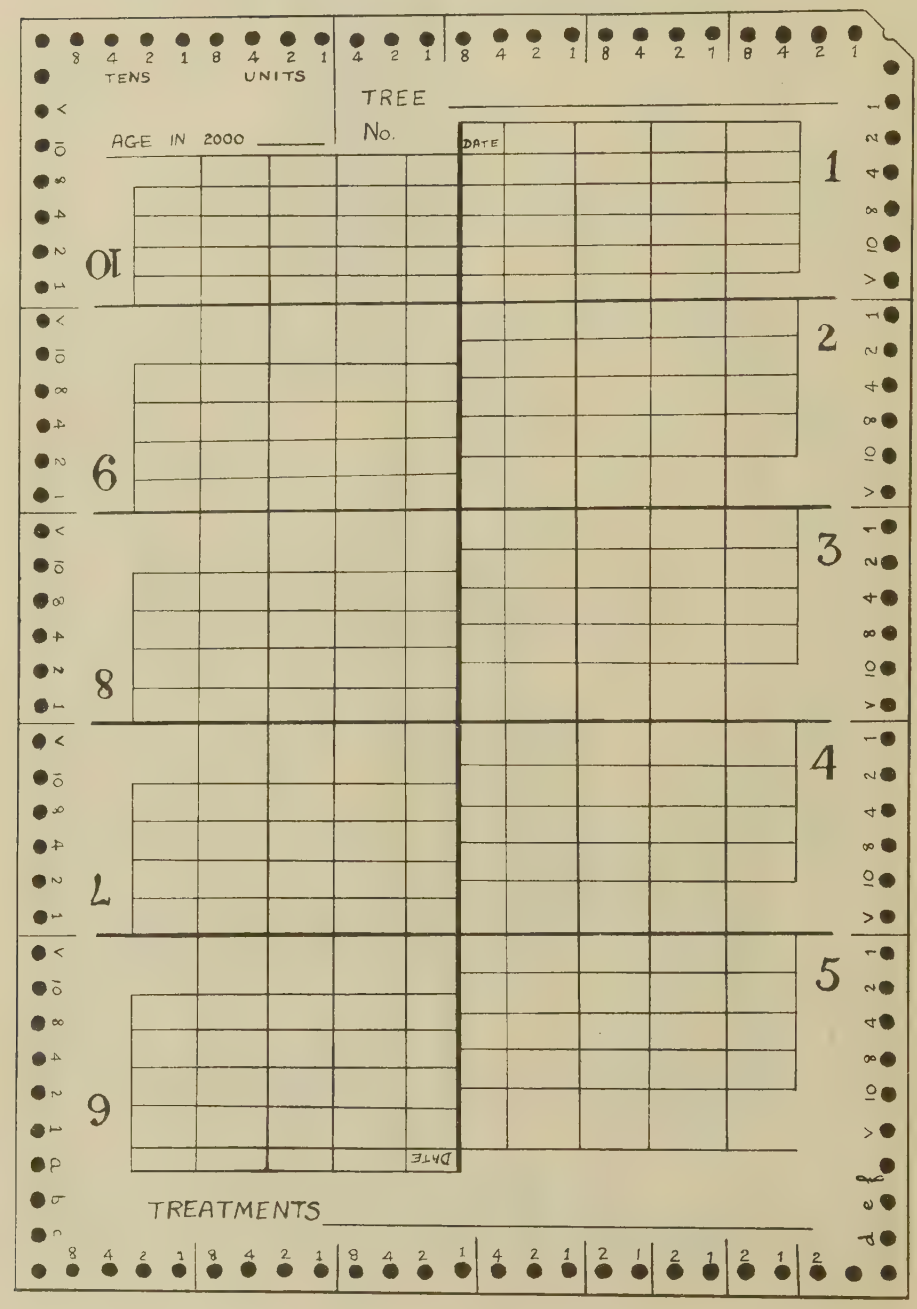
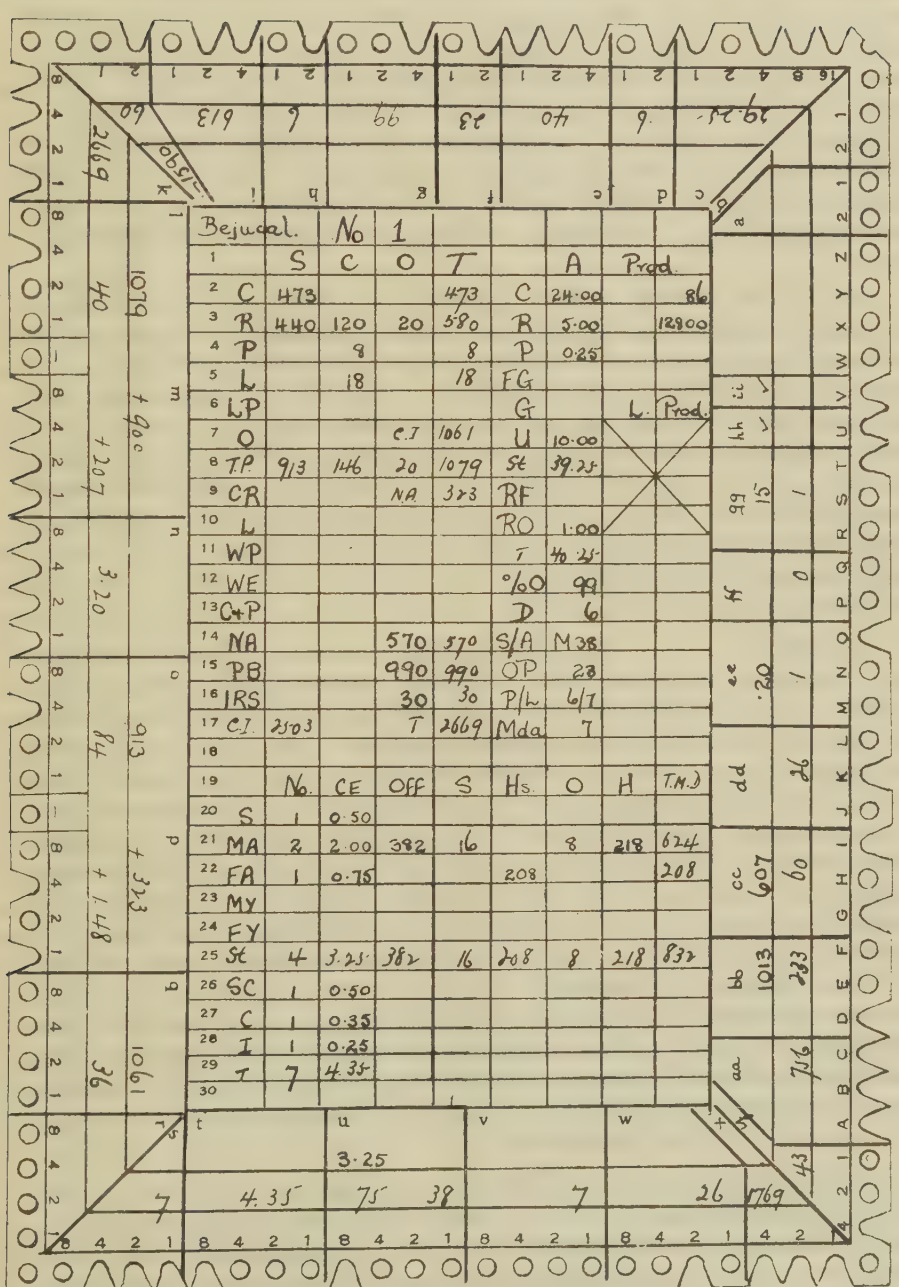


FIGURE 4
PEASANT SURVEY (FACE)



particulars such as the inclusion in a manurial or other experimental plot. If these particulars remain constant the entry of results on that site in any year will consist of an entry of the yield in the box provided on the margin of the card and any particulars of the condition of the tree as identified by the table in the body of the card (an unhealthy flush of young leaves noted in year 9, (Fig. 2)). To indicate that the permanent particulars shown on the card refer to the year for which the yield is entered the V perforation in that year is clipped. If the effective age of the tree is changed by severe pruning or by death the current card for that site will no longer be appropriate because some of the hitherto permanent information will have changed. A new card carrying the amended information will have to be made with the V clippings on this new card commencing when it is first applicable ; the V clipping on the old card will be discontinued from that year onwards. Thus, in order to make an analysis of any trees for a certain year it is necessary first to sort for the V perforation in that year to obtain all the appropriate cards.

Two routine analyses of the numbers of trees and their yields are prepared for each field each year ; one consists of an analysis of trees grouped according to age, and the other according to individual productivity. The yields are clipped in 31 yield groups ranging from 0 to 15 pounds and over, and these yield clippings are used to obtain total field and group yields by multiplying the number of cards in any yield group by the assumed mean of the group. These standard analyses have been used, among other things, to determine the most economic level of partial replanting designed to improve field production(1). The cards for the poor yielding sites are easily separated from the rest of the pack and can then be arranged in an order convenient for inspection in the field.

In addition to these standard analyses a variety of special ones have been carried out on certain fields. Manurial and cultural experiments were carried out on a group of fields and by identifying the treatment of a particular tree site the plot totals could be quickly obtained ; the possibility of sorting and grouping cards made the selection of plot size and experimental design much easier to investigate (2). The experiments varied from a simple 5×4 randomised block design to $3 \times 3 \times 3$ factorial experiments of numerous single tree plots. On single tree plot experiments the most uniform trees were required for treatment ; the cards greatly facilitated the selection of a sufficient number of individual trees for the experiments and allowed for a preliminary examination of probable experimental errors using different selection standards. A somewhat similar selection of trees was required to examine the extent of biennialism (3) in bearing of cacao trees in that only trees which had been in bearing for the greater part of the ten-year period studied were suitable for examination. Having defined the types of trees that were to be examined it was merely a process of needle sorting to separate out the trees fulfilling those requirements.

In another field of about 2,300 trees it is required to produce annually a list of the highest bearing trees (about 100) in order of their total yield for the previous three years. Most of the work in preparing this list is done by sorting on the 16 and 8 yield perforations for the three years since every tree to qualify for the list must yield at least group 8 (3.0 lbs.) in one of the three

years. By ignoring the association of any one clipping with another the following grouping can be obtained : $3\times16 + 3\times8$; $3\times16 + 2\times8$; $3\times16 + 1\times8$ and $2\times16 + 3\times8$; $3\times16 + 0\times8$ and $2\times16 + 2\times8$; $2\times16 + 1\times8$ and $1\times16 + 3\times8$, &c. A sufficient number of trees is usually obtained when group $0\times16 + 3\times8$ is reached. The actual yields for the three years are then obtained by adding and the cards within the above sorted groups are arranged manually in order of yield.

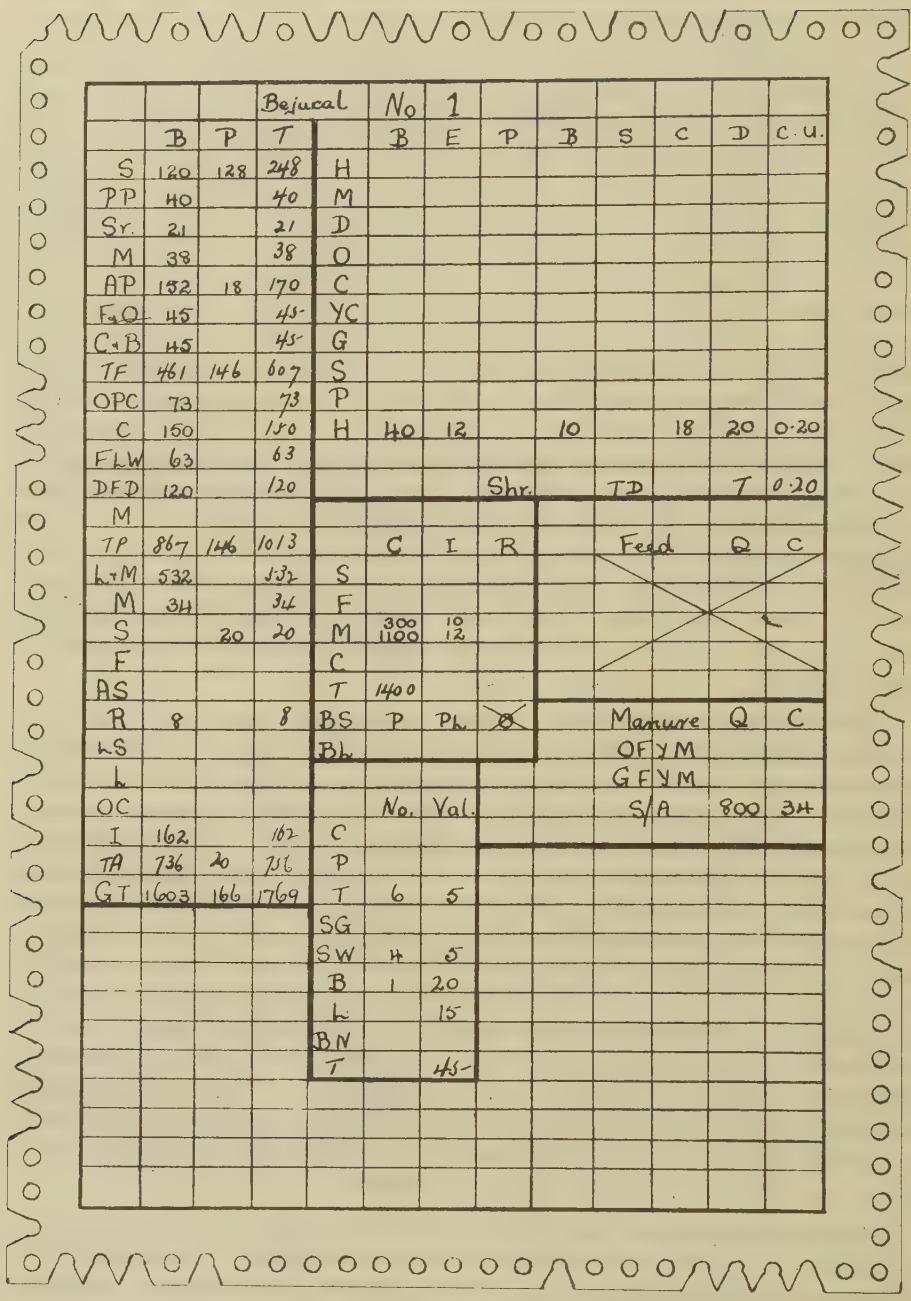
A newer design of card for cacao experiments is given in Fig.3. This card is intended to accumulate yield and other information collected in the field regarding cacao experiments in operation or projected at the College. The card provides for as many as eight types of measurement (four on face and four on the back of the card) to be entered on the card whenever observations are made up to 16 times in a year over a ten year period. It is intended that four sets of cards will be used for entering field measurements in quarterly periods. Each quarterly set will, as it is completed, be transferred to the accumulation lines of an annual set in which the total year's production will be accumulated. The card provides for identifying the individual sites in addition to any treatment identification up to the detail of 8,000, and the age of tree over a 160 year range (top of card). The treatment codings (bottom of card) are more than sufficient to accommodate any practical experimental design in the most convenient form for extracting group totals ; for instance, in a 100 clone trial the two 4-perforation boxes on the bottom left of the card can be most conveniently used to identify individual clones ; a $3 \times 3 \times 3$ manurial experiment can be most conveniently accommodated in three of the 2-perforation boxes on the right hand bottom of the card. The use of four quarterly cards in addition to an annual card is expected to facilitate the accumulation of results during the year and to allow for an analysis of seasonal results.

(*b*) *Economic surveys*—The clip-card system has also been used for economic surveys (4) (5) (6) (7) of various kinds. A typical survey card is shown in Figs. 4 and 5, representing the face and reverse side of a card carrying all the information collected about an individual peasant farmer. The difficulty experienced with such surveys prior to the use of cards was the analysis of the data when collected ; it is impossible with economic data of a group of farmers to subject them to any stereotyped statistical analysis and the laboratory investigation consists of making numerous cross tabulation analyses, one prompted by the results of the previous one, to decide what is the important information contained in the data. With ordinary tabular analyses it was found laborious to carry the process to the required limits ; every table in the sheet analysis procedure requires a re-copying of the data with the attendant risk and delay of transcription errors. There is the danger when carrying this type of work out on tabulation sheets to carry the investigation no further than a few standard analyses some of which may be misleading unless substantiated by further research.

The procedure adopted for the surveys using the cards was to reduce all the information contained in the questionnaire to compact, numerical data and enter it in a standard form on the body of the card. Red and blue ink (indicated by different handwritings in the Figures) were used to assist in identifying the position of any particular entry. When this data had been

FIGURE 5

PEASANT SURVEY (REVERSE)



Bejucal

	B	P	T
S	120	128	248
PP	40		40
Sr.	21		21
M	38		38
AP	152	18	170
F.O	45		45
C.B	45		45
TF	461	146	607
OPC	73		73
C	150		150
FLW	63		63
DFD	120		120
M			
TP	867	146	1013
L.M	532		532
M	34		34
S		20	20
F			
AS			
R	8		8
LS			
L			
OC			
I	162		162
TA	736	20	756
GT	1603	166	1769

	B	E	P
H			
M			
D			
O			
C			
YC			
G			
S			
P			
H	40	12	

	C	I	R
S			
F			
M	300 1100	10 12	
C			
T	1400		

	P	Pl.	~~Ø~~
BS			
Bl.			

	No.	Val.
C		
P		
T	6	5
SG		
SW	4	5
B	1	20
L		15
BN		
T		45-

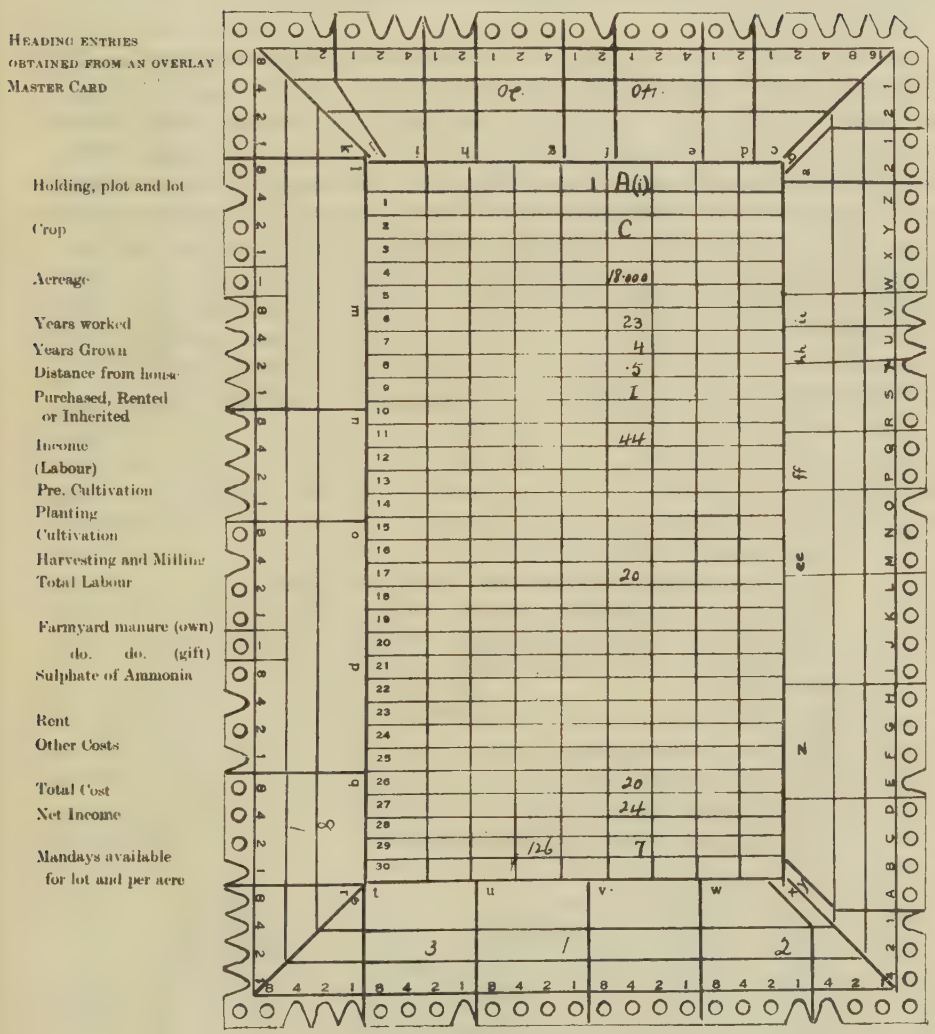
B	S	C	D	C.U.
10		18	20	0·20
	Shr.	TD	T	0·20

Feed	Q	C

Manure	Q	C
OFYM		
GFYM		
S/A	800	34

FIGURE 6

LOT CARD FOR PEASANT SURVEYS



entered all additions were checked by making totals of all the cards. A list was then drawn up of all efficiency and other factors† that were likely to be of any importance in subsequent investigation. The figures required for these calculations were, where necessary, extracted from the body of the card and entered along the border, the calculated factors being entered along the outside border of the card. As a starter a few standard analyses were made in considerable detail according, for instance, to size of holding, total income, net agricultural income, &c. These detailed analyses prompted further investigation along particular lines which were rapidly pursued merely by sorting the cards into required groups and averaging the three or four entries of particular interest.

In some surveys the cropping of the land was sufficiently simple to obtain information of the utilisation of various lots of land ; much valuable information was thereby collected regarding the peculiarities and results of individual crops. It would have been very difficult to handle these data adequately on tabulation sheets because they were numerous (1,000 odd lots of land in one survey of 168 holdings) and their value depended partly on comparison of results from lot to lot and crop to crop, and partly on comparison between lots and the holdings of which they were part. It would in fact have been impossible to foresee the most useful forms analyses of these individual lots would take. The only problem in transferring this voluminous information to cards was reducing the labour to the minimum. Labour was reduced by having a headed overlay card to act as a master with a space cut in it to enter

† (*See* Figure 4).

c	—Cultivated acreage.
d	—Average distance of lots from house.
e	—Total acreage.
f	—No. of years oldest plot of land cultivated by proprietor.
g	—Percentage of land owned.
h	—No. of parcels of land.
i	—Total income per consumer equivalent.
j	—Non-agricultural income as percentage of total.
k	—Total income.
l	—Agricultural income as percentage of total.
m (84)	—Net income.
m (21)	—Net income per consumer equivalent.
n	—Total income per total manday.
o	—Cash produce as percentage of total produce.
p (84)	—Net agricultural income.
p (21)	—Net agricultural income per manday available.
q	—Crop income per cultivated acre.
s	—No. of persons.
t	—No. of consumer equivalents.
u (84)	—Workers as percentage of consumer equivalents.
u (21)	—Age of proprietor.
v	—Mandays available per cane equivalent acre.
w	—Percentage of total mandays available for holding.
x	—Total expenditure.
y	—Agricultural expenditure as percentage of total.
aa	—Total agricultural expenditure.
bb	—Total personal expenditure per consumer equivalent.
cc	—Food expenditure as percentage of total personal expenditure.
dd	—Agricultural expenditure per cultivated acre.
ee	—No. of livestock units per cultivated acre.
ff	—No. of draft livestock units.
gg	—Livestock valuation per cultivated acre.
hh	—Cart, whether the peasant owns a cart or not.
ii	—Plough, whether the peasant owns a plough or not.

the few figures required. From the entered information certain lot factors* were calculated and clipped ; other information † relating to the holding was transferred entirely in terms of clippings from the corresponding holding card. By clipping the holding information on to four to five lot cards together the time taken in preparing these cards is trifling compared with the large amount of information available in sortable form. The whole process of preparing these lot cards occupied about one quarter of the time taken by the holding cards (Fig. 6).

The only surveys other than peasant undertaken in recent years concerned sugar estates and sugar factories in Barbados.(8) The general procedure adopted was similar to that of peasant surveys although the details were, of course, entirely different. Sugar estates, many of which did not operate their own factory, were entered on separate cards. Some of the factories produced sugar, some syrup and some both. Because the two products are dissimilar and the manufacturing methods different, the results of factories producing both sugar and syrup were split between two cards so that it was possible to obtain information about the two processes separately.

(c) *Other investigations*—The main attention of the Economics Department at the present time is directed to the use of clip cards in farm accounting ; this application is rather too specialised for discussion in this article and has been briefly reported elsewhere(9).

A card smaller than Fig. 4 has recently been used for an investigation of market reports and the supply and price of various commodities entering local markets. The labour in copying this simple information from market reports to individual cards has been well repaid by flexibility of the data in the carded form.

---

* d —Whether the lot is purchased, rented or inherited.
e —Total income per manday available.
f —Distance of lot from house.
g —Net income per manday available.
h —No. of years worked.
r —Acreage of lot.
t —Total income per acre.
u —Expenditure per acre.
w —Net income per acre.
x —No. of years crop grown.
y —Labour expenditure per acre.
z —Crop grown.

† c —Cultivated acreage.
i —Total income per consumer equivalent.
j —Non-agricultural income as percentage of total income.
l —Agricultural income as percentage of total income.
m (84) —Net income.
m (21) —Net income per consumer equivalent.
n —Total income per total manday.
o —Cash produce as percentage of total produce.
p (84) —Net agricultural income.
p (21) —Net agricultural income per manday available.
s —No. of persons.
v —Mandays available per cane equivalent acre.
ee —No. of livestock units per cultivated acre.
ff —No. of draft livestock units.
hh —Whether the peasant owns a cart or not.
ii —Whether the peasant owns a plough or not.

A projected use for clip-cards is for recording the results of soil analyses taken by the Chemistry Department on a 112 perforation card. The factors recorded include all the measurements of chemical and physical composition of the sample, and allow the site of the sample to be identified by a map reference whenever it is proposed to prepare a soil map from a group of samples.

These examples of the practical application of clip-card to agricultural data should suggest many other possible uses. The writer is of the opinion that any data requiring analysis will benefit from first being translated into card form. Such data may consist of repetitive observations similar to the cacao data above, such as measurements of plant or animal growth, periodic observation of insect or pest infestation, periodic production of livestock, meteorological data, &c. ; or they may consist of single observations of one or more kinds, such as yield, treatment and other circumstances of animals or crop plots, or quality scores of livestock or crop samples, census data, trade statistics, &c. The amount of data entered on one card is determined entirely by convenience ; it can represent as little as the supply and price of one commodity in one market for one week or it can include the main headings of income and expenditure of a 1,000 acre cane estate for a number of years.

Practical findings of the system

Ten years' experience with clip-cards have produced certain conclusions which may now be discussed. The most striking conclusion is that the usefulness of the system is rarely appreciated until practical experience has been obtained. The inexperienced are definitely inclined to over-emphasise the possible disadvantages and under-emphasise the fundamental advantages of the system. The possible disadvantages are the apparent technical nature of the clipping process and the risk of mis-clipping, mis-sorting and mis-laying cards. It has been found that the apparent technical nature of the clipping is due to its novelty rather than to any inherent complexity. Junior assistants have very quickly become accustomed to and expert at the technique, which has been aided by the adoption of a uniform coding of quantitative data ; in a very short time it becomes just as natural to clip 4, 2, 1 as to write 7. Actually much of the clipping can be done by gangs of cards having one or more clipped factors common ; indeed it is often more convenient to sort cards manually into groups of common factors and clip them group by group than to clip each card individually. Convenient systems of converting quantities into coded groups have also improved the accuracy and speed of clipping. In Fig. 4 the percentages in box W (mandays available as percentage of total mandays) were, for convenience clipped in 10 per cent. groups (group 2 covering the range 20 to 29 per cent.), although this coding did not, of course, utilise all the 16 alternatives available from 8, 4, 2, 1.

As to the danger of mis-clipping cards a simple routine is adopted for checking : if cards are sorted into the clipped groups each can be rapidly inspected to ensure that all written entries fall within the range clipped. As to mis-sorting, the visible index feature of the cards makes a constant visual check a sorting routine. It is unusual when a pack of any size is sorted for all the cards to fall at the first raising of the needle ; it becomes routine to

watch for clippings along the selected perforation to see that all clipped cards are separated before the needle is withdrawn. As to mislaying of cards, the risk of loss proves to be generally less than when the information is entered on a number of miscellaneous sheets or record books. The cards carry the information in the most compact form on a durable card of uniform size so that safe filing is simple and convenient ; the peculiar design of the cards makes it unlikely for them inadvertently to be thrown out with waste paper. A standard method is adopted for defacing any cards that are redundant. The cards being more easily counted than sheets or record books can be checked frequently by counting the number in a pack.

The practical advantage of the system is that it broadens the scope of figure work immensely without adding to the total labour of handling the data The most labour absorbing part of the card technique is usually transferring data from sheets or record books to the cards. Cards require clear and systematic entry in order to clip the information ; clipping can only be done in uniquely defined groups since there is no halfway treatment between clipping and not clipping. In making this transfer numerous questions always arise as to the degree of accuracy required for any particular entry and the precise definition of the factors represented by the numerical entries. The labour in transferring some types of data, relating for instance to an economic survey, may be very considerable and may, at first sight, appear to be additional work imposed by the card system that is not required in sheet tabulation. Far from it ! The necessity of defining and systematising the data *before* it is analysable is one of the most valuable features of the system ; if the data are not subjected to this process of definition before analysis is commenced, the lack of definition will appear only when inconsistent and unclear analyses are produced. The process of back checking and re-defining data when an analysis is underway is a most laborious and depressing occupation.

Once the data have been defined, entered and clipped on the cards, they remain permanently unequivocal and the labour required to handle them is reduced out of all knowledge. Instead of having to re-copy the entries on to separation tabulation sheets for every analysis undertaken, with the repeated risk of mis-copying and mis-grouping, entries can quite safely be transferred direct from the card to an adding machine. Some analyses can be made without even taking any figures off the cards ; for instance, the frequency distribution of any clipped factor, the highest and lowest values of any of them, the general degree of association of one clipped factor with another, can be obtained entirely by sorting and counting cards.

The fundamental advantage of all sorting systems should perhaps be finally stressed. Suppose five observations are made ; the full value of the data does not consist of any particular comparisons of the observations and only part of the information is used if observation 1 is compared merely with 2, 3, 4 and 5. In addition to these four comparisons the data contain six other comparisons of single factors and ten comparisons of combinations of factors ; with ten observations the data contain 45 comparisons of single factors alone. Any tabular entry of the observations can be made in a convenient form for only one or a few selected comparisons. Sortable card systems allow all comparisons to be made with equal facility.

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PREVENTING DAMPING-OFF IN CINCHONA SEEDBEDS

By

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Author's Summary

The results of this study indicate that damping-off disease of cinchona seedlings can be prevented by treating the beds with chloropicrin or covering the soil with sphagnum moss. Where the soil was both fumigated with chloropicrin and surfaced with sphagnum moss, germination was not impaired and growth was greatly stimulated. Seedlings grown on plots of sphagnum moss alone were entirely free of the disease but the plants suffered from nutrient deficiency. Germination and growth were good on untreated soil plots surfaced with 1 inch of sphagnum.

Cinchona seeded directly on the soil mixture germinated well, but the plants suffered severely from damping-off. Fumigation of the soil with chloropicrin prevented damping-off, but interfered with germination when the beds were seeded too soon after treatment.

The use of a sphagnum moss layer over soil either fumigated with chloropicrin or untreated is suggested for other plants which are especially tender in the early seedling stage.

Introduction

Cinchona, the tree which produces quinine and other anti-malarial alkaloids, is usually propagated by seed planted in sheltered seedbeds (2). During the early stages of growth the plants are extremely tender and susceptible to disease as well as to changes in environment. An excellent review of the literature on the diseases of cinchona has been prepared recently by Lombard (3), which includes a discussion of " damping-off," a term meaning the rapid decay or death of young succulent seedlings caused by any fungus infection. In Puerto Rico it is believed to be caused by a Basidiomycete (6) although positive identification has not been made. Other fungi are also reported as causing damping-off (3), especially *Rhizoctonia* and *Pythium* spp.

Cinchona is usually seeded on the surface of highly organic soils, where no special effort is made to control damping-off other than to reduce watering during humid weather. However, occasional outbreaks occur and considerable damage may be done before spread of the disease can be checked. Popenoe (5, *pp.* 312–313) reports some success with fungicidal solutions to control spread of the disease. Morrison (4) controlled damping-off by growing cinchona seedlings, to transplanting size, on a sphagnum moss medium in the greenhouse. One objection to this method was that the seedlings suffered from mineral deficiencies unless nutrients were supplied in the form of chemical fertilizer. The use of a sphagnum medium is restricted in many tropical areas where cinchona is grown, because of its scarcity and high cost.

Fumigation of seedbed soil with chloropicrin has been used to eliminate damping-off and other soil-borne diseases. Used first for nematode control in horticultural crops, it was later reported by Godfrey (1) to be effective against species of *Fusarium*, *Rhizoctonia*, *Sclerotium*, and certain other fungi when applied at the rate of 400 pounds per acre. At this dosage it approximates steam sterilization in effectiveness, and application is more practical under field conditions.

Materials and Methods

In the experiment reported here a comparison was made between two methods of preventing damping-off, the use of sphagnum moss as a growing medium and soil fumigation with chloropicrin prior to planting the cinchona seed. Combinations of the two methods were also tried. A seedbed 3 feet wide and 6 inches deep, located beneath a shelter house, was divided into 3-foot plots. The plots were separated by strips of corrugated zinc which extended into the ground below the seedbed level.

Experimental treatments were as follows: (1) sphagnum moss, (2) untreated soil (check), (3) treated soil, (4) untreated soil plus 1-inch surfacing of screened sphagnum moss, and (5) treated soil plus 1-inch surfacing of screened sphagnum. The sphagnum treatment consisted of 5 inches of coarse dried moss surfaced with 1 inch of screened sphagnum. The soil mixture was equal parts of screened forest leafmold and sand. The fumigation treatment consisted of injecting 2 ml. amounts of commercial chloropicrin 3 inches deep and 9 inches apart. Allowing for experimental error this dosage is equivalent to about 400 pounds per acre. After injecting the chloropicrin, the holes were closed with soil and water was applied partially to seal the soil surface. The beds were covered with waxed paper for 1 week to detain the escaping gas. No trace of gas could be detected in the soil 1 month later when a handful was held close to the eyes and nose. At that time the beds were seeded with the strain of *Cinchona ledgeriana* designated locally as Maricao No. 24. Slightly more than 1 gram was broadcast evenly over each plot. Before and after germination, watering, regulation of light, and other management were as described previously (2).

Results

Weed seeds germinated freely in the plots of unfumigated soil. It was necessary to pull these weed seedlings almost daily since they could be most easily removed before the roots became established. To pull them later would have disturbed the germinating cinchona seeds. In non-fumigated soil surfaced with 1 inch of sphagnum moss a few weed seeds germinated, but none developed in the sphagnum moss alone or in fumigated soil treatments. The difference in germination between treatments is shown in Table I.

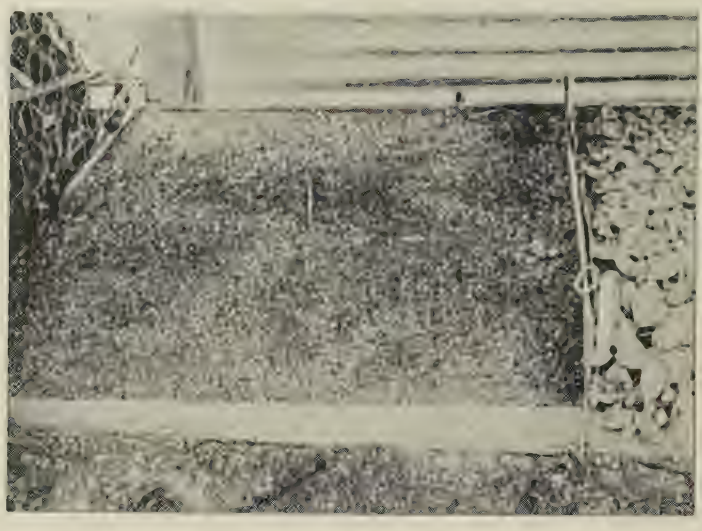
TABLE I. *Growth of* Cinchona ledgeriana *seedlings in various seedbed treatments*

Treatment	Germination	Disease	Average height of plants 5 months after seeding
			cm.
Sphagnum moss	Excellent ...	None ...	3.7
Untreated soil	Good ...	Severe ...	2.7
Treated soil	Poor ...	None ...	4.0
Untreated soil + 1 inch sphagnum ...	Good ...	None ...	4.6
Treated soil + 1 inch sphagnum ...	Good ...	None ...	7.8

A

B

Fig. 1.—Germination and growth of *Cinchona ledgeriana* Moens varied with the soil medium and treatment : A, Good germination and medium vigour obtained on soil surfaced with sphagnum moss; B, Good germination and extreme vigour on soil surfaced with sphagnum plus chloropicrin treatment.



C

D

Fig. 1 (*contd.*)—C, Good germination on soil alone but plants were killed by damping-off disease ; D, On soil plus chloropicrin treatment germination was poor but growth of medium vigour.

Germination of the cinchona seed began 2 weeks after seeding the plots and was complete in about 30 days. In general, germination was best in plots of sphagnum moss alone, which had a complete stand of uniformly spaced plants. This was attributed in part to the high moisture holding capacity of sphagnum. Germination was also good in the fumigated and unfumigated soil plots surfaced with sphagnum, but not as good as in sphagnum alone. There was no apparent difference between treated and untreated plots in stand or vigor of seedlings for the first 3 months of this experiment.

As shown in figure 1*D*, germination was erratic and poorest in fumigated soil plots not surfaced with sphagnum. A good stand of plants developed around the outside edges of these plots but the centers remained almost bare. This was thought to be a result of the fumigation, but since all traces of the gas had apparently disappeared by the time of seeding the precise reason for such poor germination is not known.

Uniform and good germination was secured in the untreated soil plots, but within 6 weeks, damping-off had started. After 8 weeks the disease had killed from one-fourth to three-fourths of the seedlings in these plots but had not appeared in any of the other plots. The disease was not completely checked by controlled watering. At this time, about 3 months after seeding, little difference could be seen in growth of the plants. It was observed, however, that plants grown in sphagnum moss alone were slightly chlorotic.

By the time the plants were 5 months in the seedbed, definite differences in growth had developed between the treatments. The incidence of damping-off increased in the untreated soil plots and one plot was completely destroyed. as shown in Fig. 1*C*. Plants in the two remaining plots averaged only 2.7 cm. in height, the smallest for any treatment. At 5 months old the other treatments were still entirely free of disease.

In the plots of pure sphagnum moss the plants apparently suffered from nutrient deficiency. Some plants in this treatment grew fairly well but most appeared stunted. The average height of plants in this treatment was 3.7 cm.

Seedlings in untreated soil with 1 inch of sphagnum (Fig. 1*A*) grew uniformly well but not as vigorously as those in treated soil surfaced with sphagnum (Fig. 1*B*). Plants in the latter treatment averaged 7.8 cm., the largest of all treatments. The difference in appearance between plots of this treatment and the other treatments was striking. Many of the plants were ready for transplanting at 5 months while in other plots an additional month was required. Plants in treated soil alone averaged 4.0 cm. in height.

Discussion

Under the conditions of this experiment, damping-off was controlled satisfactorily by covering the cinchona seedbed soil with 1 inch of screened sphagnum moss. Apparently the disease organisms were present, as evidenced by the severe loss of plants in untreated soil, but could not make sufficient headway through the sphagnum moss to reach the seedlings during the tender susceptible stage. It was also noticeable that on the untreated soil surfaced with sphagnum, infection did not take place through the root systems, which penetrated freely into the soil below the 1-inch layer. This is in agreement with a report of Stoutemyer et al (8) who inoculated flats of tender seedlings growing on sphagnum and soil media with several species of damping-off fungi. In sphagnum the fungi did not spread beyond the points of inoculation,

while most of the seedlings in soil died. On plots of pure sphagnum the plants soon became chlorotic and stunted. Germination was slightly better in this treatment, but was not considered significantly so. It is apparent that should this medium be used for seeding cinchona it would be necessary to supply additional nutrients in the form of chemical fertilizers (8, *pp.* 3–4).

In the soil plots not surfaced with sphagnum, fumigation with chloropicrin had a deleterious effect on the germination of cinchona seed. The plants which developed in this treatment were those planted around the outside edge of the plot, indicating that there was less residual fumigant in this part. It is thought that temperature may have been a factor in retention of the gas. The average minimum temperature during this season was in the lower fifties. Although the daytime air temperature was much higher, the seedbed was protected from the direct rays of the sun and probably did not warm up appreciably by day. The manufacturer recommends that chloropicrin be used at soil temperatures of at least 60°F. The month which elapsed between time of fumigating the soil and planting the seed may not have been sufficient for dissipation of all the chloropicrin. In a repetition of the experiment, seeds germinated equally as well on treated as on untreated soil. Germination was not impaired where the soil was treated with chloropicrin at the rate of 400 pounds per acre and also surfaced with sphagnum moss. In this treatment growth of the seedlings was outstanding, the plants averaging 7.8 cm. in height at 5 months old as compared with 4.6 cm. for the next best treatment. This is consistent with the experience of Godfrey (1) who reported a stimulation in growth of plants on soil fumigated with chloropicrin, due to increased mobilization of soil nutrients.

The prevention of damping-off by spreading 1 inch of screened sphagnum moss over seedbed soil, either fumigated with chloropicrin or untreated, has proved more effective in Puerto Rico than application of fungicidal solutions after the disease has attacked the seedlings, as suggested by Popenoe (5, *pp.* 312–313). The use of Bordeaux mixture has given only partial control in Puerto Rico and usually the seedbeds suffered considerable damage before the disease was checked. Stoddard (7, *p.*29) found that liquid applications of Semesan and Cuprocide, following germination of the cinchona seed, controlled spread of the disease. Treatment of the seed with these materials as dusts before planting, however, reduced the stand of seedlings by 90 percent. or more. Caution must be used in the application of chemicals to cinchona seedbeds as the young plants are more than ordinarily sensitive.

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OBITUARIES

ROBERT DE VERTEUIL, A.I.C.T.A.

The death of Robert de Verteuil on 8th April, 1950, after a brief illness, came as a great shock to his many friends at the I.C.T.A.

Robert was born in May, 1883. He was educated at St. Mary's College, Port-of-Spain, and after working for a year under Professor Carmody, Government Chemist, and for a further year at the Usine Ste. Madeleine, he went to the Montserrat district of Trinidad to serve his apprenticeship as a cocoa planter under his uncle, the Honourable Carl de Verteuil, C.M.G. at La Vega Estate. No one who served the Hon. Carl could fail to be inspired by his enduring enthusiasm for every kind of experiment in cocoa cultivation. He planted at La Vega the many types of cocoa imported by J. H. Hart, and from these, in the fullness of time, were secured an unusually large proportion of the one hundred high yielding Imperial College selections. Robert knew these trees as he knew his children.

Equipped with this sound training, Robert widened his experience by serving as manager of the Coryat Estate at Santa Cruz, Felicite Estate, Chaguanas ,and Coora Estate, Siparia. When he became manager of San Juan Estate in 1922, he was exceptionally well qualified for his life's work. From the very commencement of cocoa work at the College, the Honourable Carl, his son "Ditto" and his nephew, Robert, gave wholeheartedly of their co-operation and many of our early experiments were located on La Vega and San Juan Estates. They were the first to demonstrate the rehabilitation of seedling cocoa.

When the College Department of Botany developed the vegetative propagation of cacao on a commercial scale, Sir Geoffrey Evans, then Principal, agreed at Robert's request to let him have the first " spare " cuttings. The College at that time, and indeed for many subsequent years, possessed no land suited to cocoa, but with the encouragement of its owner, Mr. Frank Agostini, and its Manager, Robert, San Juan Estate soon became the main scene of our experiments and the Mecca of the cocoa-planting world. There can be few research workers into cocoa who have not made the pilgrimage to San Juan and enjoyed the kindly hospitality of Robert and Mrs. de Verteuil. To the College cocoa team, San Juan was a second home.

The greatest event of the year to Robert was the College excursion to San Juan. The morning visit to the cocoa field was conducted by members of the College staff; lunch was invariably dominated by our host, Mr. Frank Agostini, whose inimitable repartee furnished a highly entertaining interlude; but it was after lunch that "professor" Robert came into his own. His collection of parent rocks, specimens of cocoa and banana pests and diseases, the visual demonstration of Cheesman's cocoa classification, pods from practically all the Imperial College selections, samples of cocoa beans and prepared cocoa, all neatly arranged and labelled, furnished a wealth of material around which he wove a fascinating discourse. No exposition was complete without a cheerful West African student to serve as a foil for Robert's gentle humor.

A few months ago, Robert decided to retire from San Juan to lead a less strenuous life on a neighbouring cocoa estate. At the last College excursion to San Juan held on the 25th January, 1950, the Principal was privileged

to announce that the Governing Body had decided to institute the award of A.I.C.T.A., *honoris causa*, in recognition of Robert's long and outstanding services to the College and to the Cocoa Industry. Members of the I.C.T.A. staff took this opportunity to present him with a suitably inscribed silver cigarette case as a token of their esteem and affection.

Robert was a devout Roman Catholic and a fine Christian gentleman. He was an exceptionally good athlete and played both polo and tennis. In the latter game he represented the South against the North of Trinidad as a doubles player on many occasions. During a close friendship extending over 26 years I never heard him utter a single unkind or unbecoming thought. His friendship enriched all who were privileged to enjoy it. Robert deserves to rank among the foremost of the many de Verteuils who have distinguished themselves in the public life of the colony.

Robert married Caroline Sellier, daughter of Ernest Sellier, cocoa proprietor of Gran Couva by whom he had four daughters and eight sons, the eldest of whom—Louis Laurent—obtained his Diploma at the I.C.T.A. and is now Superintendent of Agriculture, Dominica. To his wife and surviving children we extend our deepest sympathy in their irreparable loss.

C.Y.S.

A. G. HOWELL

It is with deep regret that we have to report the death on 18th May, 1950, in Barbados, of Mr. A. G. Howell who was Registrar of the College from its inception in 1922 to the time of his retirement in 1931. Previous to the opening of the College, Mr. Howell had served from 1899 to 1922 as Chief Clerk of the Imperial Department of Agriculture in Barbados, under the directorship of Sir Daniel Morris and later, of Sir Francis Watts. The original staff of the College was drawn from that of the Imperial Department, and Sir Francis Watts became the first College Principal and Mr. Howell its first Registrar and Chief Secretary. Thus Mr. Howell had been closely associated with the development of agricultural research in the British West Indies for over 32 years. It fell to his lot to organise many scientific conferences that were held under the auspices both of the Imperial Department and later, of the College, during his period of office. After his retirement, Mr. Howell and Mrs. Howell went to live in Barbados, their native land, where he has been busily engaged in various capacities in which his long experience of administrative matters has been fully utilised.

Members of the staffs of the Imperial Department and of the College, as well as many generations of students, who were his contemporaries, will remember Mr. Howell as a sympathetic and kindly friend. His never failing courtesy, tact and quiet unassuming manner were his strong characteristics. His patience and forbearance with those students who sought his advice, particularly in regard to financial matters, were outstanding and invariably appreciated.

It was not for these attributes alone that Mr. Howell was admired by his friends, for he was a most sociable man and a keen supporter of College games as well as of the local tennis club of which he was an active playing member. He served as Secretary and Treasurer of the College Amalgamated Clubs for four years and did a great deal to foster the team spirit among our students. In these communal activities and in his home Mr. Howell was strongly supported by his wife whose reputation as a charming hostess is still well remembered by their remaining friends at the College and in St. Augustine. To Mrs. Howell we extend our deep sympathy on his passing, with the assurance that her husband's memory will long be cherished by all who have the interests of the College in mind.

F.H.